Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

FOR ALL POWER ENGINEERS • STEAM, ELECTRICITY AND ALL OTHER POWER ENGINEERING SERVICES

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The PRACTICAL ENGINEER and ELECTRICIAN

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OCTOBER 1950

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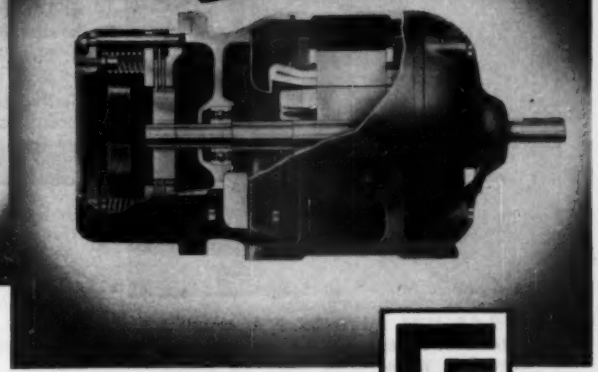

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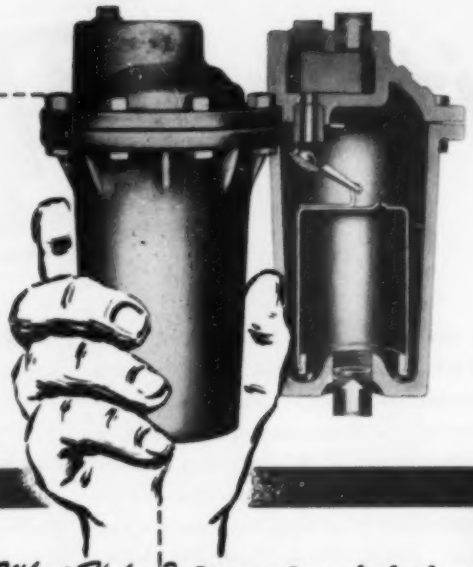

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Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

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October 1950

VOLUME 54—NUMBER 10

Notes on This Issue

Power from Volcanoes

In the famous Larderello district in Tuscany, Italy, steam from volcanic steam wells is being used as a source of power. Italy is engaged in construction projects which will greatly augment the present power development at Larderello and other volcanic areas in the world are studying the Italian developments with keen interest.

More About the Thermoelectric Generator

In August 1949 and January 1950 we published articles by Mr. Curtiss D. Bassett on his ideas and experiments concerning the possibilities of a thermoelectric generator. Our readers have written so many letters speculating on the idea that Mr. Bassett has been encouraged to continue his work. Of course, you can't buy one and maybe you never will be able to, but the theoretical possibilities of the idea certainly are intriguing to thoughtful engineers. In this article Mr. Bassett gets into 100,000 degrees F. temperatures and nuclear energy. These engineers are persistent people and you never can tell what they will dig up.

Fungi and Rope

Why an article on treatment of rope? It seems that all public utilities use a great deal of rope in underground and maintenance operations. Exposure to weather, moisture and fungi deteriorates the rope very rapidly which is not only costly but also dangerous.

So the Dayton Power and Light Co. has conducted some tests to find methods for treating rope to reduce these hazards, which is a highly practical objective of direct interest to many power engineers.

A New Institutional Plant

For several years the State of Michigan has carried on an extensive program to rehabilitate its state hospitals and institutions. The results in small power plant engineering have been notable.

This article describes in detail the new power plant built to serve the Michigan State Reformatory at Ionia.

Modern in appearance and equipment, this well-engineered plant is typical of the Michigan program and merits careful study by engineers.

The Penetron and the Probolog

They sound like something from Alice in Wonderland but are actually two new devices for inspecting tube and pipe. With the Penetron, which uses gamma radiation, the power engineer can inspect the thickness of pipe and tube walls and, being forewarned of reductions in thickness, can forestall failures.

The Probolog is an electromagnetic device which tells the condition of tube metal, that is, whether there are holes or pits or other wasting of metal. It even graphs its findings on a chart as it operates.

They are both highly useful additions to the engineer's arsenal of weapons to fight tube and pipe failures.

Temperature Limits for Steam Generators

Professor Anderson gives a straightforward presentation of temperature limits as they affect the design and operation of modern steam generators. Every power engineer should have an understanding of the inherent characteristics of the working mediums and materials of construction and the article presents a clear picture with excellent diagrams.

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ENGINEERS' PREVIEW

POINTING TO THE FACT that our world of today is steadily increasing the applications of applied science to military and industrial services, Dean Thorndike Saville of the New York University College of Engineering viewed with alarm the enrollment decline in freshman engineering classes in his annual report to Chancellor Harry Woodburn Chase, published recently.

In spite of the huge numbers of students who studied engineering during the years immediately following World War II, Dean Saville emphasized that those technically trained men have been readily absorbed by our economic system, the demands of which are growing rapidly. Unless the size of freshman engineering classes can be increased appreciably, a serious shortage of this type of personnel may develop in the next few years, he said.

"My report last year dealt with the supply of, and the demand for, engineering college graduates. The forecasts then made have been substantiated, but a number of occurrences since that time warrant renewed attention to the subject," Dean Saville reported.

"Most important was the widespread publicity in both the daily and professional press accorded a news release on 'Employment Outlook for Engineers' issued in March by the Bureau of Labor Statistics which called attention to the large numbers of engineering students graduating in June 1950, as compared with pre-war numbers, and presented a pessimistic outlook as to the immediate availability of sufficient engineering jobs to absorb them.

(We published these conclusions, along with others, for we had no reason to question them and no over-all data showing anything different. If we helped to cause any misunderstanding, we are truly sorry. — E. P. Editor)

"Worst of all was a colored pictorial chart accompanying the release which showed the rapid increase in engineering graduates since 1945 and which had a caption, 'So Many Will Be Graduated in the Next Few Years That Many Graduates Will Be Unable to Get Jobs.' This came into the hands of hundreds of high school advisors and the implications were reported in nationally distributed popular magazines. It is the opinion of a great many engineering college administrators that the impressions thus conveyed are in no small measure responsible for the sharp decline in freshman enrollment in engineering colleges for September 1950, which may well be below pre-war figures."

Dean Saville pointed out that the Bureau of Labor Statistics presented a generally "bullish" appraisal of future opportunities in engineering in its full release and report, but these were apparently overlooked in favor of the more spectacular short term forecast.

★ ★ ★

A SUBJECT INDEX to technological documents issued in Volume 12 of the *Bibliography of Technical Reports* is now available to the public, the Office of Technical Services has announced. The new index enables researchers to locate reports on any subject carried by the *Bibliography* in the period July-December 1949. Subject headings are comprehensive and include trade names where appropriate. Information on the contents of the collection in any particular field may be secured by writing to the Office of Technical Services, U. S. Department of Commerce, Washington 25.

AN UNUSUAL situation is developing in the concrete industry because of the activities of recent years in the power industry. Right now a shortage of cinders for use in cinder concrete block seems to be developing, according to one of our contemporaries in the concrete field. The power industry used to produce plenty of cinders for this purpose but now, for various reasons, is not doing so. More on this later.

★ ★ ★

THIS SEEMS to be a very opportune time to mention that the Diamond Utiliscope, the wired television system, now being rapidly applied in industry for remote observation, has the unique property of picking up objects illuminated by infrared rays. This makes it possible to see things that are in darkness so far as the human eye is concerned. For instance, if a safe in a bank has infrared rays focused on the bank door, anybody approaching the door could be seen in the monitor of the Utiliscope at some distant point. Possibilities of the Utiliscope in case of black-outs are quite evident.

★ ★ ★

UNIVERSITY of Illinois, through its Division of University Extension, offers to adults, both men and women, in co-operation with the Four Founder Societies and the Western Society of Engineers, five courses as follows: 1. Philosophy and Living; 2. Philosophies of Government; 3. Professional Engineering Refresher Course, for preparation for the Illinois Professional Engineering Examination; 4. Economics; 5. Public Speaking. Those interested in further details should communicate with T. H. Dekker, University of Illinois, Illini Center, LaSalle Hotel, Chicago, Ill.

★ ★ ★

ONE of the horrors of war that disturbs us most as we try to peer into the future is the carnage produced by gobbledygook. Business is not the only offender in this matter. Science, the professions and government bureaus have also made their contributions to bigger, harder and more unintelligible ways of saying things. Here, for example, from *The Advertiser's Digest*, is an example of the polished profundities of the Wartime Director of Civilian Defense in World War II. In a proposed letter on blacking out of buildings during air raid drills:

"Such preparations shall be made . . . during an air raid for any period of time from visibility by reason of internal or external illumination. Such obscuration may be obtained, either by blackout construction or by termination of the illumination.

"This will, of course, require that in building areas in which production must continue during the blackout, construction must be provided that internal illumination may continue. Other areas, whether or not occupied by personnel, may be obscured by terminating the illumination."

Fortunately for the safety and sanity of wartime Washington, the late President Roosevelt ordered it rewritten. "Tell them this," he said: "In buildings where work must continue, put something across the windows. In buildings where work can be stopped for a while, turn out the lights."

Few things in this world are as beautiful as a simple declarative sentence—or as rare.

A SPECIAL 18-month course to train operators for hydroelectric powerhouses to be built in the Southeast by the Corps of Engineers, has been established by the Southern Technical Institute. The name of the new job is powerhouse technician and the Atlanta Division Office of the Corps of Engineers estimates that during the next three or four years it will need 100 or more of such technicians. This is a new type of job and there is at present no other institution in the South supplying this type of training.

★ ★ ★

CARRENE-7, A New Refrigerant, has recently been announced by the research organization of the Carrier Corp. Why do we need a new refrigerant? Because motors come in definite steps of size and it is desirable to match compressor load against the motor power, also because refrigeration requirements occur at all loads and it is desirable to have small steps of capacity available to match the refrigeration cycle. The new refrigerant makes it possible to develop a series of refrigerants with suitable steps of capacity. Full details of the new Carrene-7, its composition, method of use and comparison of its characteristics with Freon 12, are given by C. M. Ashley in an article in the June 1950 issue of *Refrigerating Engineering*.

★ ★ ★

IT WON'T be long now before there will be a new contender, especially on the East Coast, for the fuel market. That is natural gas from new pipelines. It is cheap and its effects are already being felt in certain regions. True, it will be available for industrial and power plant use mostly in the summer. But still it will have its effect on all fuel prices and all future power plant design for some time to come.

The extension of gas pipelines all over the country has been going on rapidly for the past two or three years and still continues. Everywhere we go we find engineers talking about the possibility of using as much gas as they can get. Because of this interest we are planning a feature article in an early issue, at present tentatively titled, "What the Power Engineer Needs to Know About Burning Gas in Power Boilers."

It will take a bigger war than we have now to push the fuel prices up very far, says our contemporary, *Electrical World*. Total coal demand this year may not go much above 550,000,000 tons while the coal industry can mine about 700,000,000 tons per year. Fuel oil is plentiful right now and, as noted above, the gas fuel supply is being made more widely available. Nevertheless, all fuel prices could soar if the war intensifies. Right now the differential between coal and oil is relatively small and oil supplies large. Nevertheless, *Electrical World* and a number of other authorities express the belief that its price over a long period will probably stay slightly lower than that of coal. There is less pressure on coal prices because the mining industry still operates below capacity. Utilities, steel producers and other industrial consumers will take more coal as operations increase, but for the most part utilities and industry are right up to full capacity.

★ ★ ★

THE "More Power to America Special," the General Electric Company's mammoth mobile showcase of electric products for industry, headed west from Schenectady on September 5 on the second lap of its nationwide tour. The ten-car exhibit train will visit 29 key midwestern industrial centers this fall before swinging south, down the Atlantic coast.

NATION'S EXPERTS on noise will meet October 20,1950, at Armour Research Foundation of Illinois Institute of Technology to discuss excess decibels and how to get rid of them.

About 300 persons are expected to attend a National Noise Abatement Symposium where they will hear talks on the effects, measurement, and control of many types of noise. Joint sponsors of the national meeting are the National Noise Abatement Council and Armour Research Foundation.

★ ★ ★

MORE THAN A SCORE of professors from leading engineering colleges of the country spent the summer months practicing what they teach—actually helping build the complicated electrical equipment they normally meet only in text books. The 21 men were backing up text-book theories with actual practice in an unusual program sponsored by the Westinghouse Electric Corp. During the summer months, they worked side by side with the men and women who design and build electrical apparatus at several of the Company's divisions.

J. C. McKeon, manager of university relations for Westinghouse, described the plan as a "lend-lease" program whereby the colleges lend professors and Westinghouse gives them practical training, hoping in return to get better engineers when the professors' students graduate.

Each professor participating in the program was paid a regular salary by the Company, Mr. McKeon said. In each case, he was given an assignment relating to his particular field and was also given the opportunity to get a comprehensive over-all view of the Company's operations.

★ ★ ★

SIXTY SHOPMEN'S TITLES—a complete library in miniature for the factory or metalworking plant—are now available from the Office of Technical Services of the U.S. Department of Commerce.

The series, originally issued by the Government for National Defense Department shops under the general title "Industrial Notes," has been in such great demand since the first announcement of the availability of nine titles that the current major reprint was arranged.

Prices on the individual titles, all of which contain illustrations or diagrams, range from 10c to 50c but the entire series can be purchased as a unit for $15 at a saving of $1.10.

A circular and order blank describing the titles and the method of securing them is available on request. Address the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.

★ ★ ★

CARNEGIE INSTITUTE of Technology will inaugurate its fourth president and will celebrate its fiftieth anniversary, October 27 and 28.

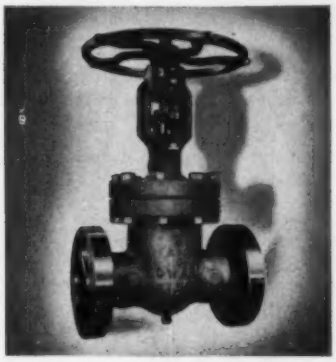
Dr. J. C. Warner, who became Carnegie's fourth president in July, will be inaugurated at 10:30 Friday morning, October 27. This will be the first inauguration in Carnegie's history. All three previous presidents took office without formal ceremony.

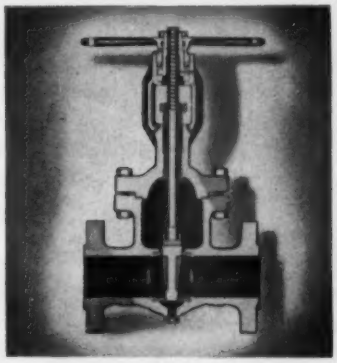
Carnegie will celebrate its fiftieth birthday, and will be toasted by one of its most famous graduates, Charles E. Wilson, President of General Motors Corp. and a member of the class of 1909.

Dr. Robert E. Doherty, who retired from the Carnegie presidency this year (see E. P., Aug., page 7), will come to the celebration with Mrs. Doherty from their new home in Winter Park, Florida.

WANTED

INFORMATION AS TO THE WHEREABOUTS OF ONE EDWARD GATE VALVE WHICH ISN'T PERFORMING SATISFACTORILY!





DESCRIPTION: Close fitting wedge guides prevent wear-producing wedge drag on seating faces—accurately located with respect to seating faces and wedge, then welded integral to the body while master wedge is still in place • Looseness eliminated and wear reduced to a minimum • One-piece bonnet aligns stem accurately • Needless weight and unnecessary working parts eliminated • Two tight seating faces • Ball bearing yoke makes operation easy • Uniform metal sections reduce distortion in heating and cooling • Integral but replaceable hard surfaced seats greatly lengthen valve life.

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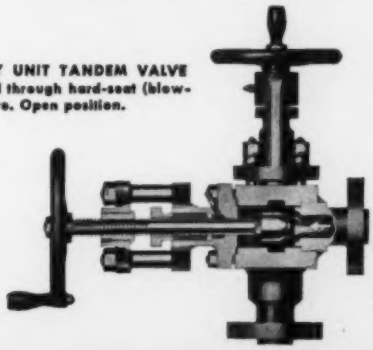
Yarway continues to pioneer and improve blow-off valves and blow-off valve service for both high and low pressure applications.

On new boilers, replacements or modernization, make sure you specify Yarway Blow-Off Valves. Any boiler manufacturer will supply them on your specification.

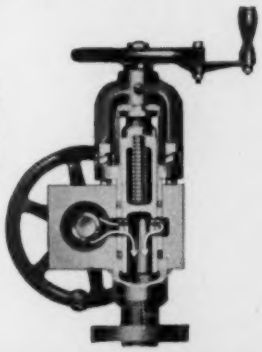
Bulletin B-424 gives you the full story on pressures to 400 psi. Bulletin B-433 for higher pressures. Both are free. Write...

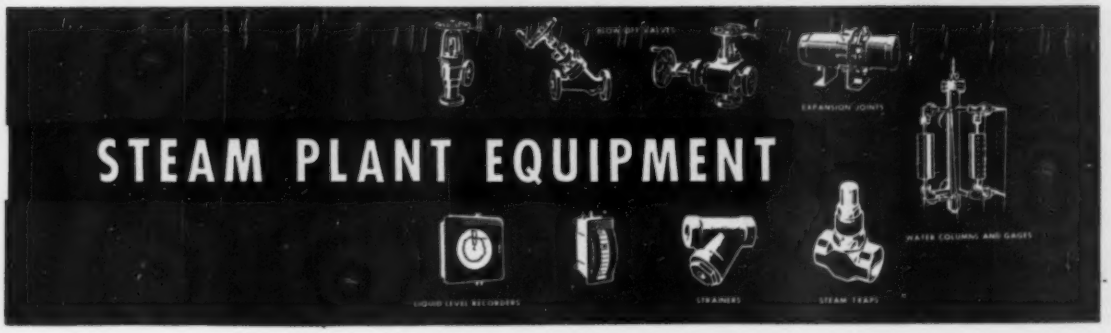
YARNALL-WARING COMPANY, 114 Mermaid Ave., Philadelphia 18, Pa.

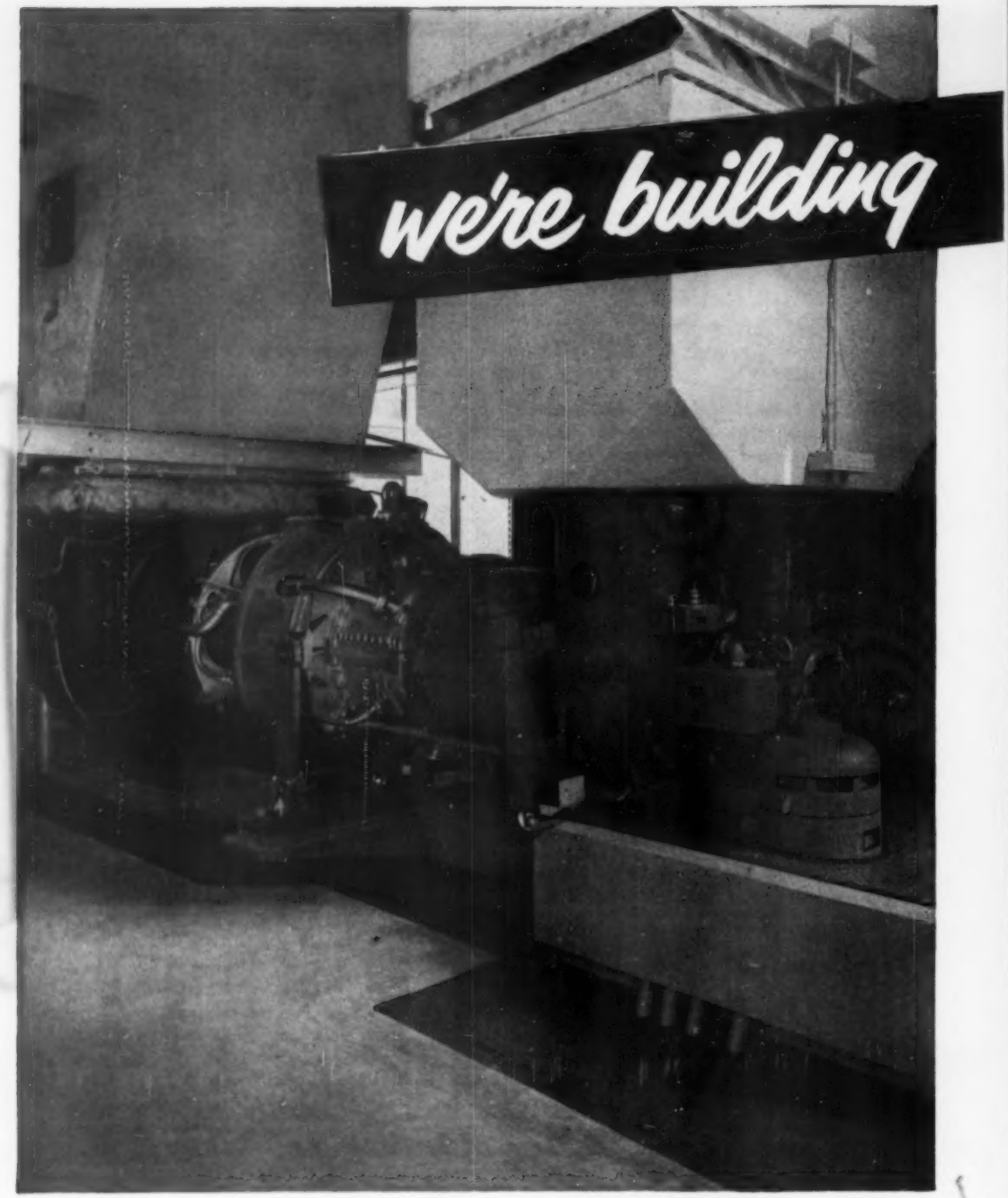
YARWAY UNIT TANDEM VALVE sectioned through hard-seat (blowing) valve. Open position.



YARWAY UNIT TANDEM VALVE sectioned through seatless (sealing) valve. Open position.







America's first gas-turbine power plant for power generation is this General Electric 3500 kw unit installed at the Belle Isle Station of the Oklahoma Gas and Electric Co.

MORE Gas Turbines

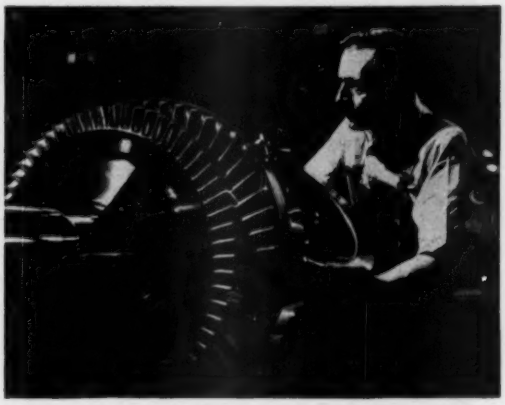
AMERICA'S *New* PRIME MOVER

Three General Electric combustion gas-turbines—the first in America—have been placed in regular service. Full-scale production has begun on several basic designs, and in the next few months, more will be coming off the test stands in G.E.'s newly completed gas turbine factory.

The efficient, reliable and profitable performance record of the units already placed in revenue operation has established the gas turbine as an important prime mover. It offers several unique advantages: Each unit is a complete plant in itself. It is small and compact, easily operated, and requires but a minimum installation investment.

General Electric gas-turbine generators, rated 3500 kw and 5000 kw, are available to meet your requirements. They are backed by the experience that has given G-E steam turbines a position of leadership for more than 45 years. If you're interested in power generation, you'll want the facts about these new power plants. Write for your copy of bulletin GEA-5516, "Gas Turbine Power Plants," today. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

Assembling compressor casings requires the supervision of experienced craftsmen. While many manufacturing experts will "grow up" with gas turbines, responsibility for producing the first units falls on the shoulders of men who have spent years building steam turbines, turbosuperchargers, and jet engines.

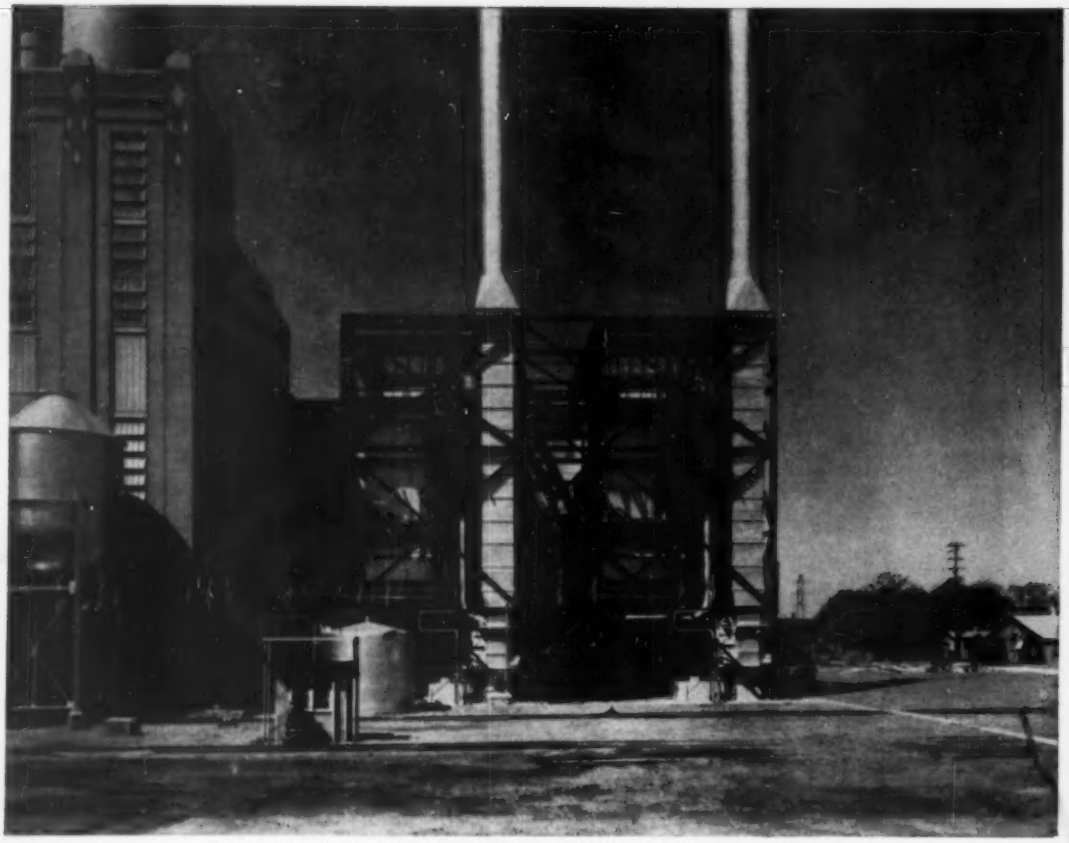


Though gas turbines require many components which may be new to the power engineer, the heart of the unit is still the familiar turbine wheel. Designed on principles established by steam turbine experience, this two-stage turbine rotor is given a final micrometer inspection before assembly in a new power plant.

GENERAL ELECTRIC

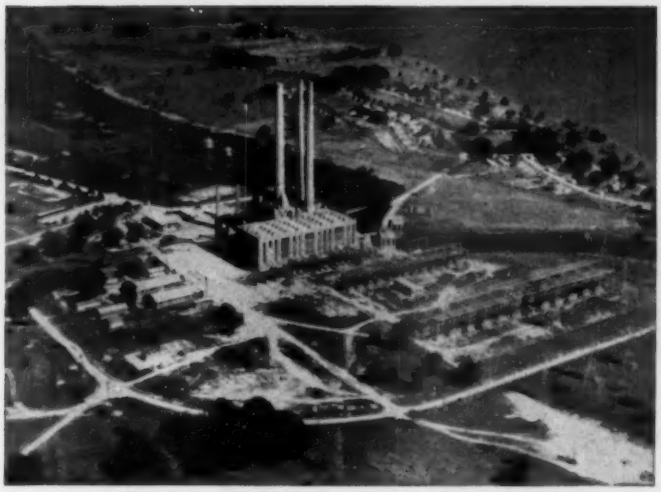
254-48

Two Outdoor Boilers Under Automatic



Outdoor Installation of Two Large Boilers at the Trinidad Steam Electric Station.

Aerial View of Trinidad Steam Electric Station. (Note the Two Outdoor Boilers Installed Behind the Main Building).



Control

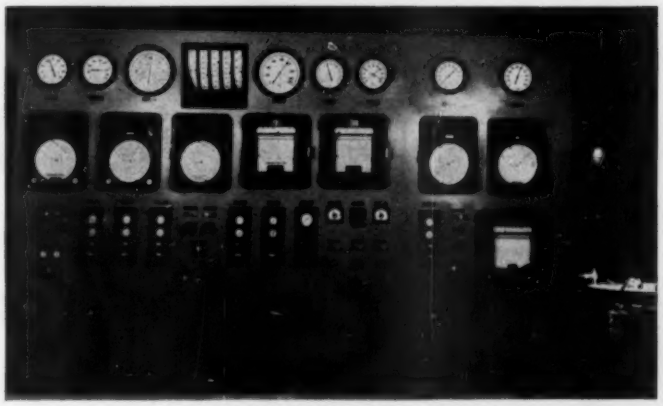
at TRINIDAD STEAM ELECTRIC STATION • Texas Power & Light Company

● A most important part of the Texas Power and Light Company expansion program at their Trinidad Steam Electric Station, is this outdoor installation of two new gas fired, 350,000 lb. per hr. boilers. These boilers, operating at 920 psig., provide 70,000 KW additional capacity to meet the increasing power demand on the Trinidad Station. To achieve maximum efficiency and performance, the boilers were put under completely automatic control.

The AUTOMATIC COMBUSTION CONTROL system and the PRESSURE REDUCING AND DESUPERHEATING STATION were supplied by REPUBLIC FLOW METERS CO.

A Potent Tool for Cutting Costs

A properly engineered automatic control system is an effective way to cut power costs. Best of all, what automatic control is doing for the large plants such as the Trinidad Steam Electric Station it is also doing for their smaller brothers. But the full benefits can only be realized if the plant designer selects with great care the best control equipment for his job. The control must be carefully matched to the boiler and auxiliary equipment characteristics; it must maintain maximum combustion efficiency under all load conditions.



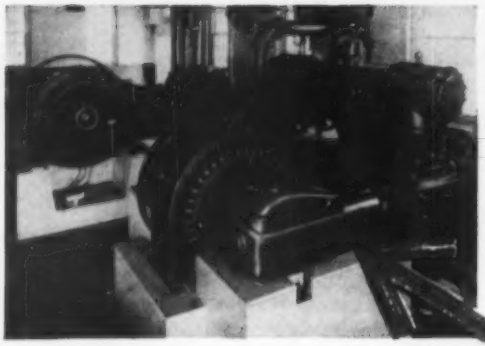
One Section of the Boiler Control Panels.

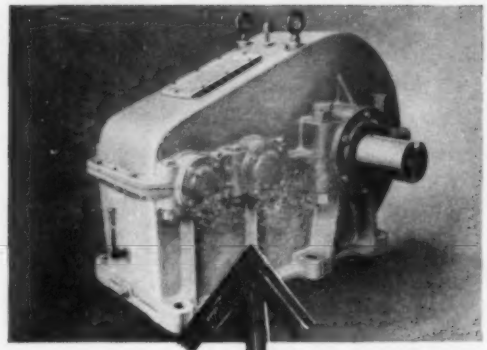
REPUBLIC CONTROLS are available for all types of load fluctuations, fuel firing, single or multiple fuels, and all types of boilers and auxiliary equipment. Backed by thirty-six years of specialized experience in combustion control, REPUBLIC'S power engineers have developed control systems to answer every type of steam generating problem.

Ruggedly built to outlast the boilers that they serve, REPUBLIC AUTOMATIC CONTROL gives you the best, most economical system engineered to suit your needs.

For more information on REPUBLIC AUTOMATIC CONTROL write for Data Book No. S-21 or contact our field engineer nearest you.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS





For the best lubrication use SINCLAIR RUBILENE

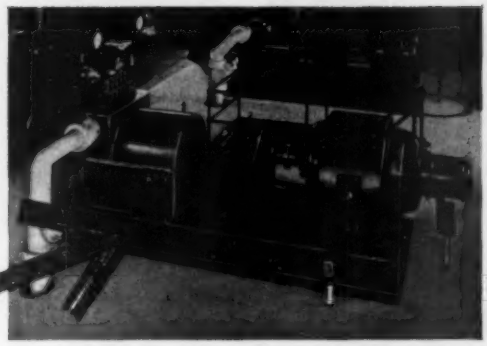
Over many years engineers in power plants throughout the country have accepted Sinclair's Rubilene as the finest available lubricant for power house equipment.

Sinclair Rubilene has always been a top-quality oil, as it has been constantly improved through the years, incorporating the latest technological developments in refining and processing. It resists oxidation under continuous high temperatures, and recirculation. It separates rapidly from water and is non-foaming. Through long periods of use it retains its original qualities, providing uniform, trouble-free lubrication and low maintenance costs.

Yes... Rubilene's finer quality pays dividends in the power plant.

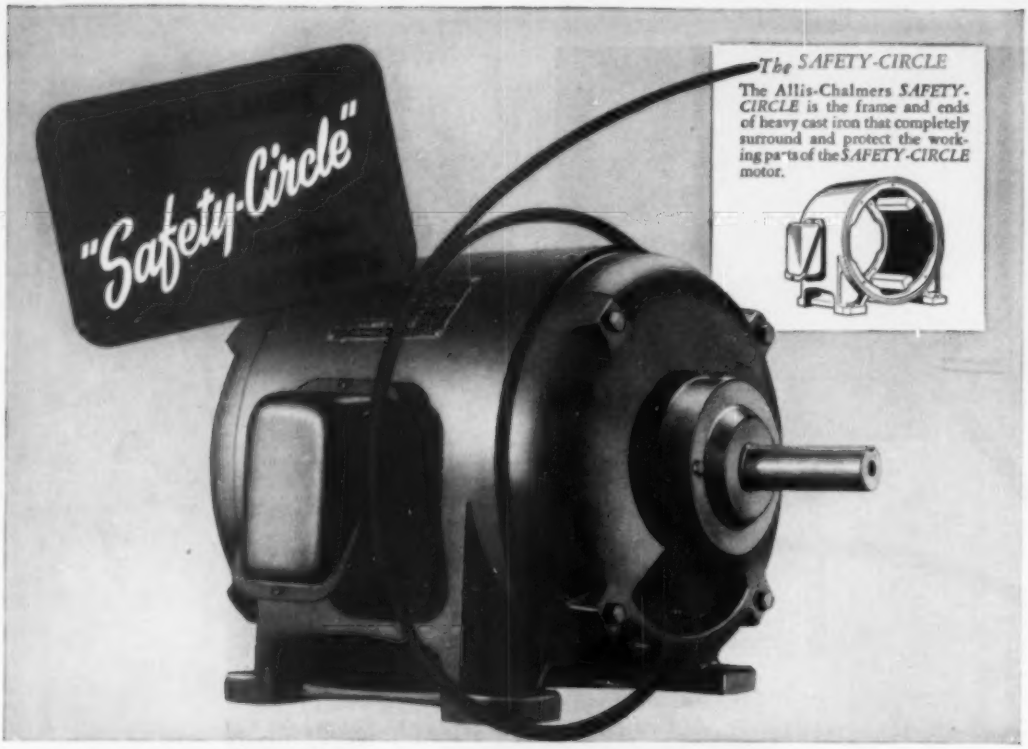
SINCLAIR

For lubrication counsel . . . see your nearest



REFINING COMPANY

Supplier of Sinclair Products or write to Sinclair Refining Company, 630 Fifth Ave., New York 20, N. Y.


"Safety-Circle"
The SAFETY-CIRCLE
The Allis-Chalmers SAFETY-CIRCLE is the frame and ends of heavy cast iron that completely surround and protect the working parts of the SAFETY-CIRCLE motor.

SAFETY-CIRCLE means

★ All-Around Protection ★ Low Maintenance ★ Dependable Performance

A-3144

THE *SAFETY-CIRCLE* MOTOR is protected all around against those four great motor killers — corrosion . . . distortion . . . friction . . . foreign matter. The frame is of cast iron, the most corrosion-resistant material for this purpose.

The strength and stiffness of the cast iron is supplemented by ribbing and bracing to maintain alignment and prevent distortion. Ball bearings are lubricated and sealed at the factory. They require no attention for years. End brackets are drip-proof at no premium.

SAFETY-CIRCLE motors are fully protected inside, too. Multiple-dipped and multiple-baked stator plus extra inter-phase insulation provide extra protection against electrical breakdown.

With *SAFETY-CIRCLE* protection outside and protected working parts inside, you can count on years of trouble-free, low cost power.

For complete details on *SAFETY-CIRCLE* advantages, see your A-C Authorized Dealer or Sales Office or write for Bulletin 51B6210B. Stocked in sizes 1 to 20 hp. *SAFETY-CIRCLE*, *Texrope* and *Vari-Pitch* are Allis-Chalmers trademarks.

ALLIS-CHALMERS, 953A SO. 70 ST.
MILWAUKEE, WIS.

Sold . . .
Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and Vari-Pitch sheaves, speed changers.

PUMPS — Integral motor and coupled types. Sizes and ratings to 2500 GPM.

ALLIS-CHALMERS

You Save on 4 Counts with ENCO STREAMLINED BAFFLES

1 Better heat transfer

Enco's improved baffle design insures a uniform, high velocity gas flow over every square foot of heating surface.

2 Low draft loss

Smoothly curved baffles maintain a cross-flow of gases across the tube banks. Dead gas areas, bottlenecks and eddy currents are eliminated.

3 Less steam, less time for cleaning

Soot doesn't get a chance to accumulate in pockets. Soot blowers are used less often. Streamlined baffles lower maintenance costs.

4 Custom installation

Experienced Enco crews take charge of the installation, repairs and replacements of your individually designed streamlined baffles—do the job thoroughly and quickly with minimum downtime.

BULLETIN BW44 tells the full story, contains complete engineering data, explains how Enco Baffles provide maximum steam output with minimum fuel consumption. WRITE FOR YOUR FREE COPY TODAY!

THE ENGINEER COMPANY

75 WEST STREET, NEW YORK 6, NEW YORK

IN CANADA: F. J. EASTON, LTD., 4220 IBERVILLE ST., MONTREAL 34 P.Q.

LINE UP for low-cost steam...
with the B&W Type E Pulverizer

Five B&W Type E Pulverizers, serving a B&W Radiant Boiler of 800,000 lb. per hr. steam capacity.

RECIRCULATING LOAD – DRIES AS IT GRINDS

Recirculation of fines within the mill gives repeated, quick-drying contact with large masses of heated air and metal... produces proper fineness at all loads, even with coal as wet as it can get. Fines are classified in the mill.

UNIFORM PERFORMANCE REGARDLESS OF WEAR

Balls and grinding rings wear together... assure uniform fineness regardless of attrition of the grinding elements . . . fineness automatically increases at reduced loads.

BLOWS CLEAN AIR – SAVES WEAR AND TEAR

Unique in pressurized operation, the Type E Pulverizer requires remarkably little maintenance of the primary fan, because it blows only clean air . . . is not subject to the damaging abrasion of entrained particles.

New Bulletin G-57 illustrates and describes the design, construction, operating and maintenance features of the Type E Pulverizer. Write: The Babcock & Wilcox Company, 85 Liberty Street, New York 6, New York.

ONE-POINT VARIABLE FUEL-AIR CONTROL

Like the accelerator on your automobile . . . assures proper coal-to-air mixture . . . produces desired rate of steam generation over a wide range with coal conditions suitable for sustained high combustion efficiency.

LOW POWER CONSUMPTION

Ball-and-ring grinding, anti-friction bearings, pressure lubrication, and automatic rejection of ungrindable materials make possible high output with minimum power demand.

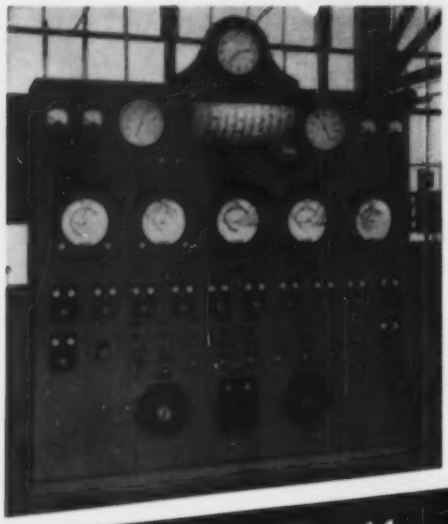
OUTSTANDING PERFORMANCE RECORD

Availability and maintenance economy beyond today's most exacting requirements are proved in over 1300 Type E Pulverizer installations.

Helping Industry Cut Steam Costs Since 1867

BABCOCK & WILCOX

G-504T



This Bailey Boiler Control Panel in a mid-western industrial plant saves fuel and insures safe operation of a 100,000 lb per hr, 175 psi, sat., pulverized coal and gas-fired boiler.

What's Your Control-Dollar Efficiency?

Control-dollars frequently bring annual investment returns of 100% or more. When you buy adequate, well-applied steam plant controls, you increase your dollars' ability to work usefully for you.

That's where Bailey can help: Bailey Controls can give you a better control-dollar efficiency. Here's why:

1. **Complete Range of Equipment—fully co-ordinated.** You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. **Engineering Service—backed by experience.** No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement and automatic control.

3. **Direct Sales-Service — conveniently located near you.** Bailey Meter Company's sales-service engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

•

For better control-dollar efficiency—for more power per fuel dollar, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More power to you!"

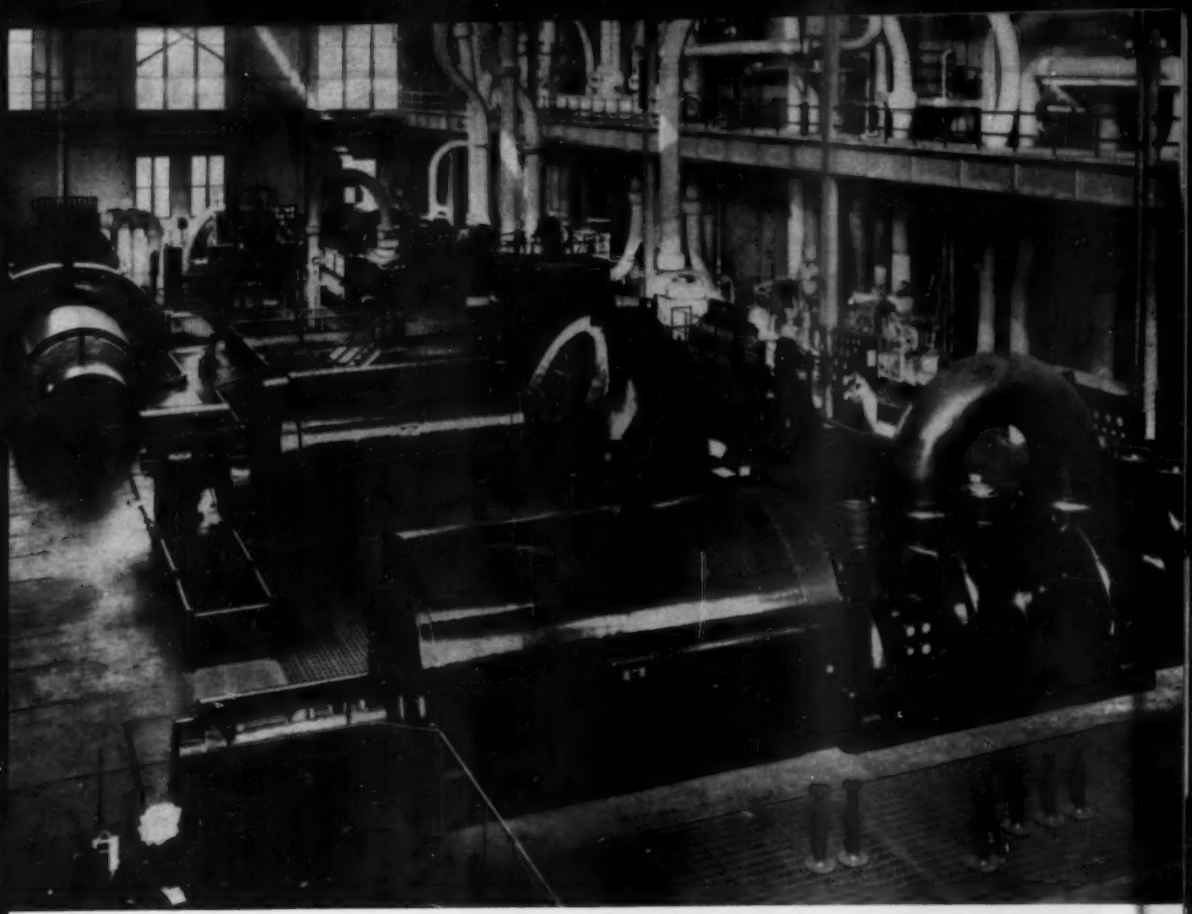
A-112-1

BAILEY METERS

BAILEY METER COMPANY

1040 IVANHOE ROAD
CLEVELAND 10, OHIO

Controls for Steam Plants



Turbines in the Kansas City Power and Light Company's Second and Grand station: a 10,000-kw., a 11,500-kw., a 20,000-kw., and two 35,000-kw. units, all lubricated with NONPAREIL Turbine Oil.

Turbines stay on the job, so does ➡ ➡ ➡

USED first in a 20,000-kw. turbine in 1936, NONPAREIL Turbine Oil today lubricates five turbines, totaling 111,500 kw., in the Kansas City Power and Light Company's Second and Grand station. Reason for this acceptance is easy to find in the oil's low acidity records.

In the oldest fill (14 years), the neutralization number has not exceeded 0.10 mg. KOH/gm., and in all five fills it has averaged only 0.07 mg. KOH/gm. The consistently low acidity of NONPAREIL has kept turbines on the job and minimized maintenance time.

Gain these advantages by using NONPAREIL in your turbines: no oil replacements, no removal of oil for treatment, no cleaning of oil systems and governors. For evidence of these advantages, ask a Standard Oil lubrication specialist to supply you performance data from the 20-year service record of NONPAREIL Turbine Oil.

NONPAREIL
TRADE MARK
Turbine Oil

You can reach a lubrication specialist through the nearest local Standard Oil (Indiana) office or by writing:

Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY (INDIANA) STANDARD

TERRY

QUICK-STARTING
TURBINE
FOR FEED PUMP
EMERGENCY DRIVE

The turbine shown at the right picks up the feed-pump load in case the motor, which normally drives the unit, is inoperative. Thus the turbine must be able to start quickly and be completely reliable —characteristics which are assured by the generous blade clearances and one-piece construction of the Terry Wheel.

This is but one example of many special turbine requirements that are met by the Terry solid-wheel turbine. Details on how this and other Terry Turbines will meet your individual needs will be gladly supplied by a Terry engineer.

DATA

The turbine is 620 hp, 3550 rpm for 850 psi, 900F steam with 2.5 psi back pressure.

Installed in the Crawford station, Middletown, Pa., Metropolitan Edison Co. Gilbert Associates, Inc. were the consulting engineers.

T-1178

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

When will your spare boiler be drafted?

AS LONG AS the present international situation continues, defense production will be at a high level, and almost every plant may be called on to participate—which means that at any moment your 'spare' boiler may be needed in regular service.

Under these circumstances, unscheduled boiler outages mean *lost production*, at a time when production must be kept high.

Proper conditioning of boiler water is a major factor in boiler availability—and Hall Laboratories have been leaders in boiler water conditioning for more than a quarter of a century. They are prepared to recommend procedures which, in your specific situation, will give most desirable results at minimum investment and lowest operating costs.

Hall Laboratories are not, however, limited to boiler water conditioning. Hall also offers *plant-wide* water service, for every problem concerning the use of water in industry comes within the scope of Hall activities. May we send you a copy of the new Hall bulletin "Your Most Important Raw Material"?

Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

HALL *plant-wide* WATER SERVICE

BOILER WATER CONDITIONING

PROCUREMENT, TREATMENT, USAGE AND DISPOSAL OF INDUSTRIAL WATER

Who Buys VU-10 Boilers?

A quick answer is that VU-10 purchasers include industrials ranging from very small to the largest, as well as schools, hospitals, institutions, and, in fact, every type of establishment that requires boilers in the VU-10 capacity range. Why, then, limit the list of representative users on the opposite page to names known to everyone as among the biggest industrial enterprises in the country? Because such names form a significant guide for a prospective boiler buyer, in the same sense that the buying decisions made by operators of large truck fleets can be a reliable guide for the man who wants to buy a single truck.

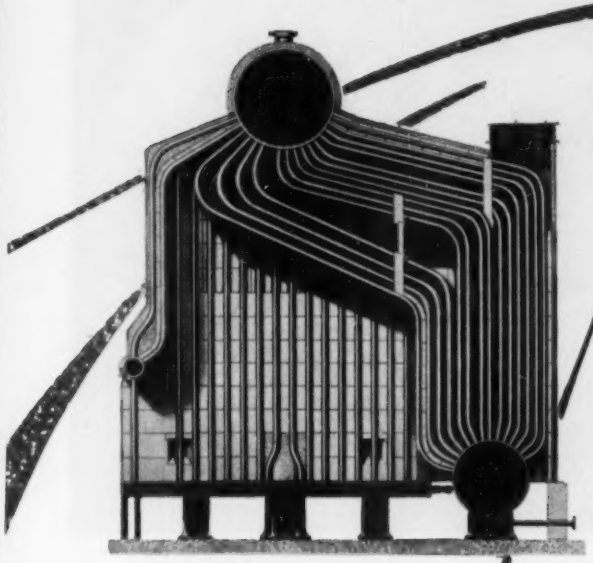
This reasoning applies *especially* to the purchase of a boiler. Big companies buy boilers frequently . . . therefore their experience is always up to date. They buy them for plants in many locations, using many different fuels. They buy them in capacities from very small to very large. Their requirements justify the employment of highly qualified engineering specialists—both staff men and outside consultants. Thus they have the breadth of experience and the expert guidance requisite to making the soundest equipment selections.

And perhaps equally important, big companies tend to place more emphasis on long-term operating and economic results. They know from their own experience that daily operating economies accruing through the years from better design and construction features will quickly offset the difference in first cost between the cheapest boiler they can buy and the best the market affords.

So if your steam requirements call for boilers in the capacity range from 10,000 to 60,000 lb of steam per hr, we submit the acompanying representative list of large companies that have purchased VU-10 Boilers as a sound reason for confidence that your decision to buy a VU-10 will prove to be a highly profitable one—not only for the first few years of service but throughout the lifetime of the installation. B-423

COMBUSTION ENGINEERING

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



C-E Vertical-Unit Boiler

Type VU-10

The VU-10 Boiler is designed for industrial load conditions and particularly for plants having small operating and maintenance forces. Capacities range from about 10,000 to 60,000 lb per hr. Firing may be by spreader, underfeed, chain or traveling grate stokers, or by oil or gas burners. Superheater, economizer or air heater surface may be added if desired.

Representative large companies that have purchased VU-10 BOILERS

Air Reduction Company
American Locomotive Co.
Armour & Company
Borg Warner Corporation
Thomas A. Edison, Inc.
Ford Motor Company
Robert Gair Company
General Foods Corporation
B. F. Goodrich Chemical Co.
Illinois Packing Company
Johns-Manville Products Corp.
Jones & Laughlin Steel Co.
Liebmann Breweries, Inc.
Liquid Carbonic Company
National Distillers Chemical Co.
New York Central R.R.
Owens-Illinois Glass Co.
The Pennsylvania Railroad
Remington Arms Company
Revere Copper & Brass Co.
R. J. Reynolds Tobacco Co.
Joseph Schlitz Brewing Co.
Sharpe & Dohme, Inc.
Sunshine Biscuits, Inc.

— SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.

Built to Cut Maintenance

EASIER MAINTENANCE PROCEDURES and lower maintenance costs are important features of this brand new line of large motors. One man can perform all routine maintenance procedures, including opening up the motor for cleaning. Bearing surfaces are not exposed to abrasive grit and dirt during cleaning operations.

The appearance of this new line of large motors reflects the advanced design and fine workmanship that goes into their manufacture.

A well-braced, sturdy fabricated steel frame with cast-iron end brackets rigidly support and protect working parts. Ventilating openings are large to provide adequate cooling air at low velocities with resultant low sound level.

Wide Range of Sizes

These new design Allis-Chalmers drip-proof and splash-proof squirrel-cage induction motors are built in sizes from 60 hp at 300 rpm to 1500 hp at 1800 rpm. Ask your Allis-Chalmers representative to show you the details of this exceptional new motor or write for Bulletin 05B6112.

How's This for Accessibility

One man can remove the end brackets and air baffles and reach right inside motor with his vacuum cleaner or air hose. Bearing remains sealed against abrasive dirt throughout the cleaning operation.

Large air discharge openings with removable louvers allow plenty of room to get in with an electric drill for doweling and bolting the motor to the base. Plenty of room to reach up back of the stator core for cleaning.

A-3179

ALLIS-CHALMERS, 953A SO. 70 ST.
MILWAUKEE, WIS.

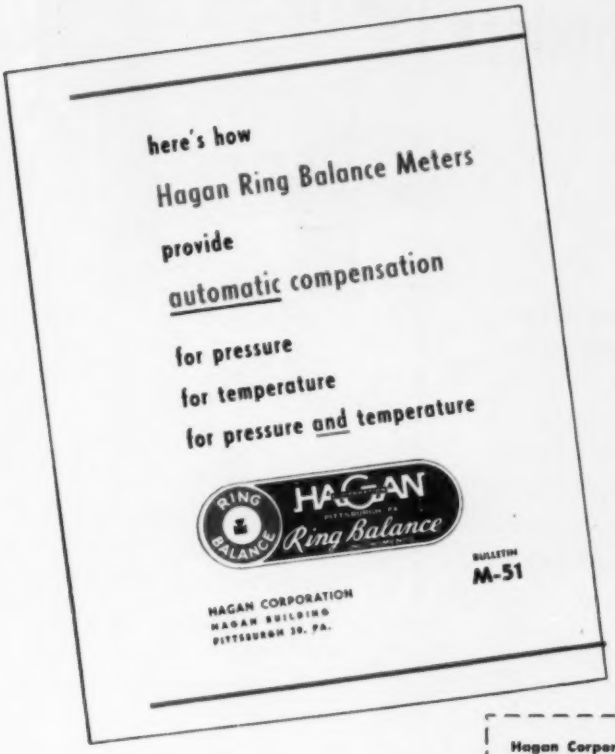
ALLIS-CHALMERS

AUTOMATIC COMPENSATION

for pressure or temperature
or BOTH
with

HAGAN

Ring Balance Meters



When actual pressure and temperature differ from the base conditions used in the orifice calculations, a "correction factor" must be applied to the readings of any conventional flow meter.

Several more common uses of these corrections are in connection with natural gas fuel supply, steam heating distribution systems and extraction stage steam measurement.

Hagan Ring Balance Compensated Flow Meters correct automatically for variations in temperature or pressure, or both. The chart reading is the compensated reading. The uncompensated record may also be produced on the same chart, as well as records of the flowing pressure and temperature.

The Ring Balance principle makes the addition of pressure and temperature compensation so simple that compensated meters are standard models in the Hagan Ring Balance line—not a special "problem child."

Detailed information on these meters is contained in our new bulletin "Here's How Hagan Ring Balance Meters Provide Automatic Compensation for Pressure, for Temperature, for Pressure and Temperature." To get your copy, just fill out the coupon below, or write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

Hagan Corporation
Ring Balance Meter Division
Hagan Building, Pittsburgh 30, Pa.

Please send me a copy of your new bulletin, "Here's How Hagan Ring Balance Meters Provide Automatic Compensation for Pressure, for Temperature, for Pressure and Temperature."

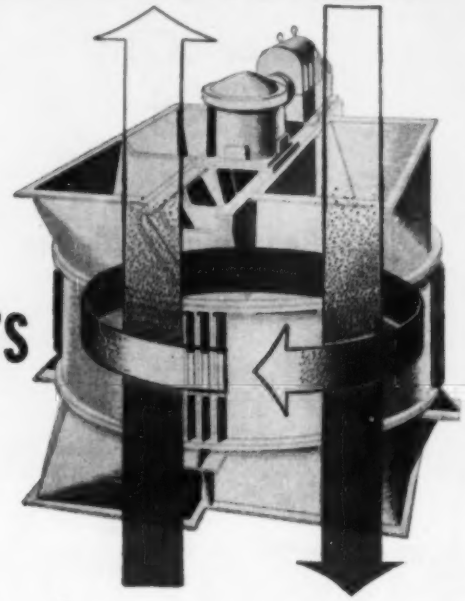
NAME_____

STREET_____

CITY_____ STATE_____

PE-10

How the Ljungstrom Air Preheater can modernize "middle age" boilers



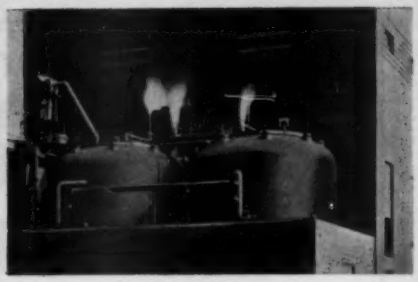
The lightness and compactness of the Ljungstrom Air Preheater makes installation possible on "middle age" boilers with minimum change in the existing structure. This addition of the Ljungstrom Air Preheater, with its continuous regenerative counterflow principle permits operation at lower exit gas temperatures . . . assuring increased heat recovery and reducing the amount of fuel required.

In a matter of a few years the Ljungstrom Air Preheater will effect savings that will more than offset the initial installation cost. If you are interested in approaching modern performance standards with your "middle age" boilers, our engineers will welcome the opportunity to show you how the Ljungstrom can raise the overall efficiency of your plant.

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves the heat is transferred from the waste gases to the incoming cold air.

THE AIR PREHEATER CORPORATION
60 East 42nd Street, New York 17, N. Y.

BIRD'S EYE VIEW OF A COCHRANE HOT PROCESS SOFTENER



Above, in normal perspective, is the two-stage Cochrane Hot Process Softener, installed at Corn Products Refining Co. at Argo, Ill. Capacity is 120,000 GPH Makeup. Total Capacity 1,000,000 lb./hr. The softener serves two 250,000 lb./hr. 650 psig. boilers which operate on 100% makeup. Maximum boiler feed is 350,000 lb./hr. per boiler, a total of 700,000 lb./hr. The two sedimentation tanks are identical in size, one furnished for lime and soda ash treatment and the second for phosphate treatment.

Looking down on the two-stage softener at Corn Products Refining Co., Argo, Ill.

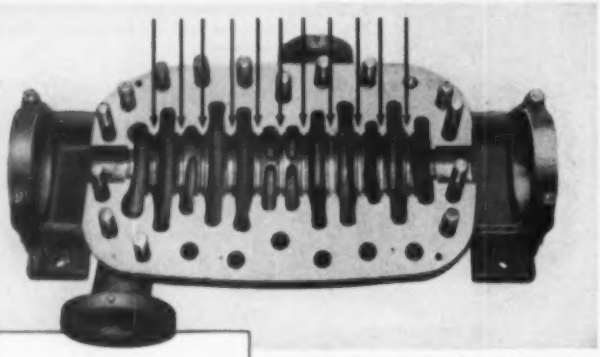
Cochrane first introduced the method of water softening at high temperature early in the century. Constantly improved, the Cochrane Hot Process Softener today is in use in industry's most important plants in all parts of the world.

COCHRANE CORPORATION · PHILADELPHIA 32, PA.

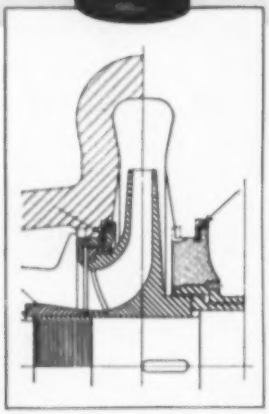
In Canada: Canadian General Electric Co., Ltd., Toronto
In Mexico: Babcock & Wilcox de Mexico, S. A., Mexico City
In Europe: Recuperation Thermique & Epuration, Paris

IN YOUR BOILER FEED PUMPING...

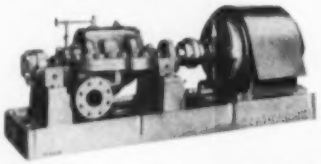
Get **HIGH** *reliability at* **MEDIUM** *pressure with* **LOW** *maintenance cost*



Lower casing half of a Worthington 6-Stage Type UR Centrifugal Volute Pump. Arrows point to joints protected by Worthington Elastic Seal Rings.



Worthington Elastic Seal Ring construction (solid black areas) in a Type UX Pump. Flexible and resilient, the Elastic Seal Ring assures initial seating, makes joints liquid-tight, eliminates a common cause of pressure loss.



This Worthington Type UQ Pump incorporates the Worthington Elastic Seal Ring, latest improvement in mechanical design.

WORTHINGTON

WORTHINGTON PUMPS, TYPES UQ AND UR, ARE TOP PERFORMERS AT PRESSURES UP TO 950 PSI

In power plants throughout the world Worthington Centrifugal Pumps, Types UQ and UR, have proved themselves the most modern small-capacity boiler feed pumps in the medium pressure range. Correct in every mechanical and hydraulic detail, they feature:

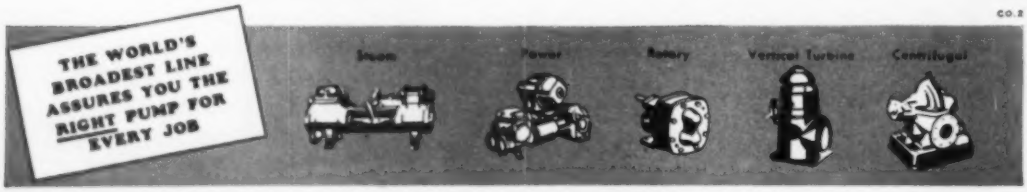
- **Balanced design . . .**
- **No stuffing box trouble . . .**
- **Freedom from interstage leakage . . .**
- **Low Maintenance Cost**

Built for long, trouble-free service, these multi-stage volute-type pumps are by far the most dependable and economical for your boiler feed jobs at pressures up to 950 psi.

There's A Worthington Pump For *Every* Pressure Range

from 100 psi to 2400 psi and all outstanding in their class. In this most complete line you're sure to find exactly the right pumps for your own boiler feed requirements, large or small. For further proof that *there's more worth in Worthington*, contact our nearest District Office or write to *Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, N. J.*

CO.2



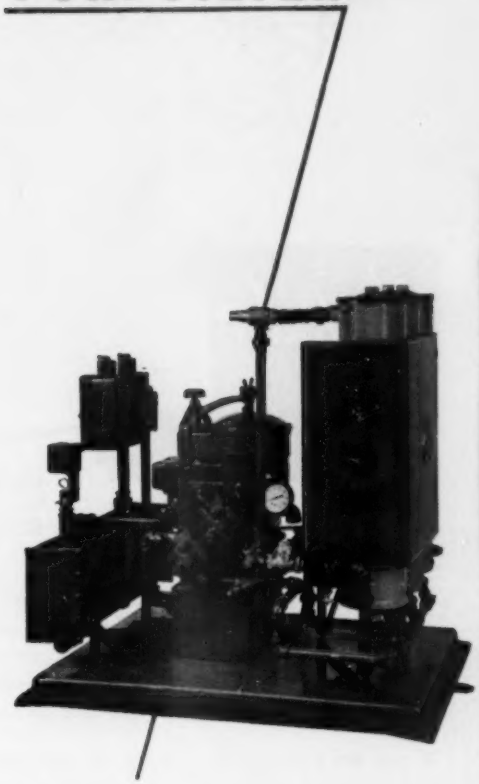
GET RID OF *GUMS, SLUDGES and COKING*

with the DE LAVAL "PURI-FILTER"

The materials in Diesel lubricating oil that cause ring sticking, sludging and "coking" can readily be removed by the De Laval "Puri-Filter." The "Puri-Filter" consists of a De Laval Centrifugal Oil Purifier in combination with Fram filters. The action of centrifugal force and filtration is so powerful that it readily frees Diesel lubricating oil of these solids that cause trouble.

While it is true that many detergent oils enable such solids to remain in suspension, the "Puri-Filter" provides a simple, sure way of eliminating these impurities as fast as they form. The "Puri-Filter" is the finest means ever discovered for keeping Diesel lubricating oil ***really*** clean, and, of course, dry.

The De Laval "Puri-Filter" is surprisingly economical to operate. The centrifuge takes out such a large percentage of all impurities that cartridges in the filters need be replaced at relatively infrequent intervals.



THE DE LAVAL SEPARATOR COMPANY
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DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

DE LAVAL *Oil Purifiers*

FOR DIESEL LUBRICATING OIL

PINPOINT SKETCH OF INDUSTRY-WIDE SATISFACTION

Photo of 4' x 6' wall map of Nalco Industrial Department. Each pin locates a user of The Nalco System. Pins in Great Lakes are Nalco System ships.

NALCO System installations and ships*—each a pin in the map above—literally blanket the industrial and fresh water navigation areas of our country. The reason is simple: *satisfaction with Nalco chemicals and services.*

If you are not already getting the efficiency and economy of The Nalco System in your plant, now is the time to find out about it. Best Nalco Salesmen are Nalco Users—and there are sure to be several near you. For prompt Nalco Service, call or write today.

**This map does not show the thousands of miles of railroad lines and terminals served by Nalco . . . That requires another large map by itself!*

NALCO CHEMICALS AND SERVICES

- **WATER TREATMENT**—Chemicals and Consulting Services. Boiler feedwater, internal and external, locomotive and stationary. Cooling waters. Paper and pulp mill processing waters. Chemical and Food processing waters. Potable waters (slimicides and softening).
- **COMBUSTION CATALYSTS**—SR Series Chemicals for coal and oil fuels.
- **ANTIFOAM AND STABILIZATION** chemicals for water and other liquids in process.
- **LABORATORY RESEARCH**, commercial analyses, consulting services.
- **PAPER AND PULP MILL** pitch and clay control, size control, slime and mold prevention.

Additional information on any Nalco Chemicals and Services will be furnished without obligation.

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6224 W. 66th Place • Chicago 38, Illinois
Canadian inquiries should be addressed to Alchem Limited, Burlington, Ontario

THE *Nalco* SYSTEM...Serving Industry through Practical Applied Science

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

ELECTRICAL

101 **Power Factor Correction**—Examples illustrating basic considerations in the improvement of system power factor are contained in Bulletin 2287402, 4 pp. It points out economical and operational advantages of improving plant power factor and advisability of keeping the load power factor up to 0.8 lagging or higher, and tells how the effects of low power factor can be inexpensively corrected by the judicious use of synchronous motors or a synchronous condenser. Allis-Chalmers Mfg. Co.

102 **Dry Type Transformers**—Bulletin 120, 12 pp, describes and illustrates company's line of dry type transformers, including open coil and completely enclosed types, unit substations and core coil units in sizes ranging from 0.1 kva to 2000 kva. Discusses advantages of these transformers—increased safety, elimination of vaults or firewall construction, reduction of bus runs by locating transformers near load centers, and reduction of voltage drop between center and load. S. E. Upegrafi Mfg. Co.

103 **Industrial and Special Capacitors**—What is described as an unusually complete line of capacitors is presented in 48-pp Catalog 300, which also covers resistors, vibrators and test instruments. Book is indexed, fully illustrated and arranged for easy selection of units to meet practically every capacitance requirement. Includes full ordering data on company's new ceramic capacitors as well as electrolytic, paper, metallized paper and mica types. Aerovox Corp.

104 **Tough Conductor**—A nickel-clad copper conductor combining the toughness and corrosion-resistance of nickel with the conductivity of copper is described in the single-sheet bulletin, Form 80/Old-8111. Tells where this conductor is being used successfully, available sizes, forms. Alloy Metal Wire Co., Inc.

105 **Manual on Electric Insulation**—This 8-pp illustrated booklet introduces Glastic, a popular-priced, Fiberglas-reinforced polyester laminate for electrical insulation said to offer increased impact strength, dimensional stability and resistance to heat, moisture and arcing. Tells composition of product, gives its mechanical, electrical and chemical properties and includes comparison data on this and other plastics. Also describes other available grades of Glastic. Touches briefly upon fabrication of Glastic and available molded parts and includes a price list on industrial panel stock, also a free sample. Laminated Plastics, Inc.

106 **Weather-Proofed Switchgear**—Outdoor metal-clad switchgear designed for all-weather protection, operating convenience and safety are described and illustrated in 8-pp Bulletin 1B36142A. Among features described are poured-on steel plates to provide barrier between instrument panel and circuit breaker compartment, and welded-in steel floor plates to keep out water, moisture, animals and vermin. The bulletin has a table of ratings and dimensions, a floor plan, diagrams of standard assemblies, and circuit arrangements for standard circuit breaker units. Allis-Chalmers Mfg. Co.

107 **Rapid Action Ground Detector**—Introduced in this folder is an instrument for use on electrical distribution systems and equipment which finds the ground and indicates the grounded phase in a matter of minutes—while the power is on and the machines are running. Consisting of a pulsating signal generator and signal receiver, the equipment may be installed in the sub-station or used as portable unit. Equipment is pictured, its operation diagrammed and explained and its use illustrated by a series of photos. The economy and efficiency of the detector in preventing shutdowns and unnecessary labor and damage to plant are stressed. Ferr Mfg. Co., Inc.

108 **For Foreign Buyers of Generating Equipment**—Form A1S5C is a 12-pp booklet prepared for the export market. It illustrates and describes briefly company's equipment available for export—gasoline and diesel-powered electric generating plants, air-cooled four-cycle engines, separate ball bearing generators, water-cooled marine generating plants, accessories, and such specialized models as a 130-amp d-c portable welder. Provides helpful suggestions for negotiating export documents which include instructions in determining terms of payment and establishing the letter of credit. D. W. Onan & Sons, Inc.

PUMPS, COMPRESSORS

109 **Centrifugal Pumps**—Single and two-stage centrifugal pumps, size 1 to 5 for a variety of applications including small boiler feed service, cooling tower service, condensate service, bottle washing, brine circulation, general water service and hot well service are presented in illustrated Bulletin W-305-B1. Includes ratings, dimensions and specifications, instructions on how to select a cold water pump. Worthington Pump and Machinery Corp.

110 **For Hazardous Pumping Jobs**—Bulletin 48-5400 describes and illustrates pumps designed for handling butane, propane, ethane and other volatile hydrocarbons. Explains basic principle of pump design which is without a stuffing box and which has oil-filled motor and close-coupled pump enclosed in a sealed unit. Includes photos and cutaway illustrations of several models with various types of pressuring systems, also pictures of some typical installations. Byron Jackson Co.

111 **High Pressure Pumps**—Data Sheet 64-B describes manufacturer's recently designed 3-in. stroke direct flow pumps—a series which includes 3-, 5-, and 7-cylinder units. Covers their design advantages, construction specifications and drive requirements. Also included are a pump selection chart, dimensional drawings, and plunger, pressure, and capacity data on the 5- and 7-plunger units. Capacity range of these two pumps is 202 to 3000 bbl per day at 160 rpm. The Aldrich Pump Co.

112 **Vertical Pumps**—Catalog P500, 16 pp, is devoted to vertical centrifugal pumps for sewage disposal, underpass service, reduction plants, drainage, pumping paper stock and similar applications. Stresses non-clogging feature of the

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...pumps, Sterilus and Simplex construction and design features. Also discusses vertical dry pit drives and direct-connected units. Includes data on typical installations, selection tables, dimensions. Rotary Pumps, Inc.

113 **Heavy-Duty Compressors**—Company's 7 Series of compressors for heavy duty service in 7½, 10 and 15 hp sizes are described and illustrated in this 8-pp bulletin. Compressors are available in models for normal hydrostat pressure of 100 to 125 lb, as well as models rated to 200 lb pressure for continuous duty and to 250 lb intermittent pump-up service. Photos show packaged units and cutaway illustrations show design features. Engineering data, also dimensions included. Ingersoll-Rand Co.

114 **Compressor Protection**—Gas leaflet describes briefly a new refrigeration control designed to save the compressor from damage by shut off of its electric power by means of its safety head. Photos show how this safety head control is designed and how it functions. Safety Head Control Co.

INSTRUMENTS AND CONTROLS

116 **Flow Regulator**—Bulletin 302, 4 pp, on company's direct-acting flow regulator features a large cutaway illustration which clearly shows how the regulator works. Specifications are given for regulators from 0.1 to 100 gpm. Larger units of this self-contained regulator are available. It's intended for controlling flow of water, acids or oils. W. A. Kates Co.

115 **Liquid Level Indicators**—Twenty-pp Bulletin WG-1222 is company's newly-published edition covering liquid level indicators and auxiliary attachments for remote indication of liquid level in boilers, feed water heaters, storage tanks. Discusses eye-level readings afforded accurate indication of changes and other advantages of the indicators. Auxiliaries described include automatic control units for operation of distantly located alarm, signal lights, horns or electric switches. Provides complete construction and operating details, installation suggestions, dimensions, application diagrams, pictures of typical installations and ordering data. Yarnall-Waring Co.

117 **Diaphragm Draft Gages**—Illustrated line Bulletin 124, 4 pp, describes straight gages of the diaphragm type. These differ from company's bell type, in that they are actuated by a free floating diaphragm of silk that's impregnated and sealed with an airtight synthetic material to resist cracking from repeated flexing. Other features described are the transistent ceramic scale, pointer, and bronze pivot bearings in recording mechanism. Dimensional data included. Bloom Draft Gage Co., Inc.

MECHANICAL POWER TRANSMISSION

118 **Engineering Data on Speed Drives**—Variable speed drives available in eight sizes and 16 types, from ¼ to 25 hp, and with manual and automatic controls, are illustrated, listed and described in 32-pp Book 1274. A special feature of this book is the convenience with which a drive of the right specifications for a specific service may be selected directly from its 16 pp on prominent drives. Diagrams of automatic speed control applications and photos showing a great variety of industrial installations are included, as are ratings, dimensions, data on accessories. Link-Belt Co.

119 **Remotized Speed Control** — Company's automatic Vari-Pitch drive, a simple low-cost method of instant speed control covering most speed changing needs from ½ to 60 hp is described in 12-pp Bulletin 2277-A. Illustrated text explains that to increase speed you move the motor toward the driven sheave, moving it away decreases speed. Belt tension is automatically maintained and a speed variation of approximately 2 to 1 is possible. Use of this automatic sheave on textile machinery, pumps, blowers and compressors, variable frequency generators and other equipment is told and some installations are pictured. Includes instructions and tables to enable you to figure components needed to assemble a drive for almost any speed range and horsepower within range of this drive. Allis-Chalmers Mfg. Co.

120 **Worm Gear Drive Manual**—Full engineering and ordering data on company's worm gear drives is presented in 36-pp Book 2224. Illustrated with photos and sketches it discusses types of drives and construction features and provides selection tips. Provides ratings, dimensions, overhung and thrust loads on several types of single, helical and double worm gear drives, and contains many photos of applications. Included with book is 8-pp current price list. Link-Belt Co.

121 **Hydraulic Couplings**—Bulletin 2286 in Vol. II of "Progress in Power," a 24-pp collection of company's advertisements covering the use of hydraulic couplings in power plants. They feature on-the-job interviews in public utility plants and depict the increased efficiency through the entire plant afforded by the use of fluid drives. American Blower Corp.

122 **Belting Price List**—Something new —and needed—is the simplified price list this company has compiled for its leather conveyor and power transmission belting. Avoiding complicated tables and discount clauses, this list is intended to let the buyer see at a glance what length and ply he needs, how much it costs and how it is shipped. The Philadelphia Belting Co.

MAINTENANCE, CONSTRUCTION

123 **Wire Rope Reference Data**—Bulletin 80-38, 4 pp, was published to fill the need for a quick-reference source of all information pertaining to improved plow steel wire rope. All sizes and construction classifications are combined in one large table. Wire rope strand classifications are illustrated. Includes information on how to order wire rope and describes wire rope construction. Macwhyte Co.

124 **Curtain Wall Construction Data**—Form 3818, 24 pp, is a progress report on the methods prescribed for use of stainless steel curtain walls. Describes briefly and illustrates non-structural and structural stainless steel facing, reinforcing stainless steel facings and combined system with structural insulation. Gives construction details covering vapor vents, joints, attachments and windows. Also discusses shapes and textures available and possibilities for large size curtain walls. Allegheny Ludlum Steel Corp.

125 **Uses of Rubber Putty**—Catalog Section 9765, 1 pp, is on company's Plastikon rubber putty recommended for many types of glazing and sealing and particularly adaptable where vibration, corrosion, or moisture exists. Cites advantages of the product, gives directions for use, lists stock colors and grades. The B. F. Goodrich Co.

TRAPS

126 **Air Relief Traps**—Ball float traps for venting air from any liquid under pressure are described in Bulletin 288, 2 pp. Typical applications for the traps are described, as venting air from water service lines, hot water heating sys-

(Continued on page 112)

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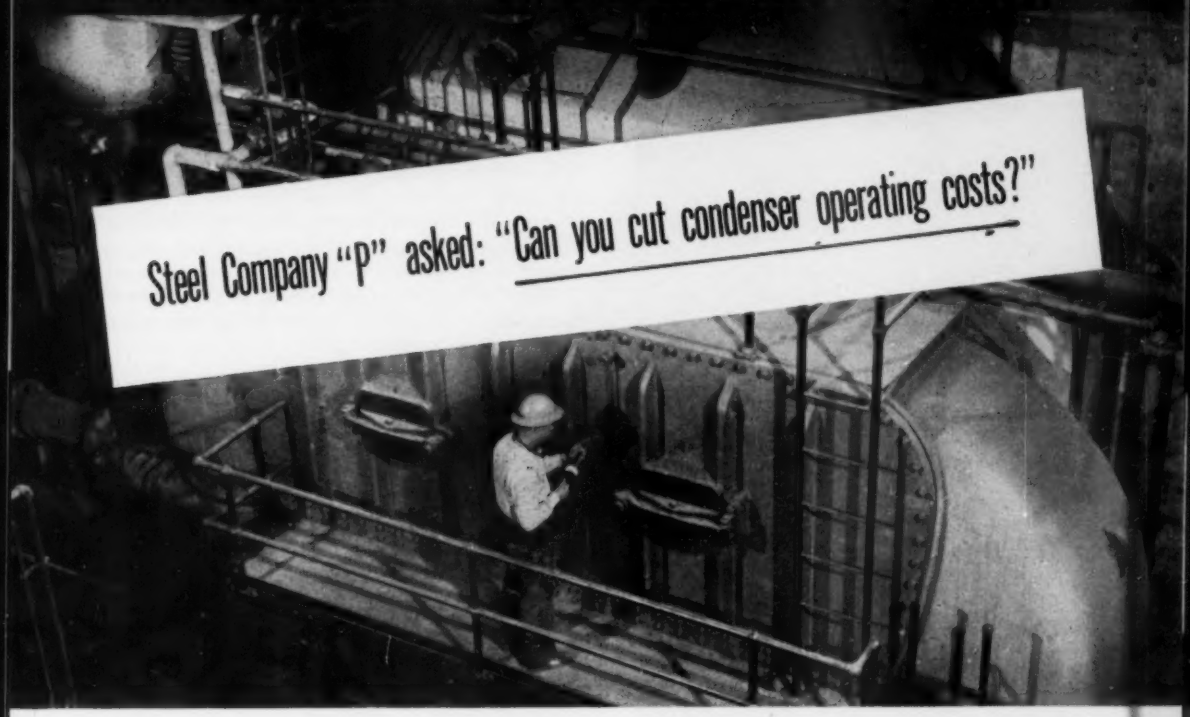
DOWELL SERVICE

CHEMISTRY APPLIED TO MAINTENANCE CLEANING PROBLEMS



Dowell Service saved $87.92 in steam per day!

Dowell Service was used by a major steel company to clean a large turbo blower condenser. After the cleaning, operating figures showed a saving in steam of 8000 lb. per hour or a dollar saving of $87.92 per day. At this rate, *Dowell Service paid for itself in 5½ days!*

There are many places in every industrial plant where Dowell Service can be used to cut operating costs. Wherever deposits on the surfaces of condensers, boilers, heat exchangers, water lines and other equipment are stealing power, Dowell Service can show money-saving results.

Dowell Service has another prime advantage for the maintenance engineer. *It is fast!* Because cleaning is done chemically, time-consuming dismantling is eliminated. Dowell engineers fill the equipment with liquid solvents that go wherever steam and water flow. These solvents are designed to remove deposits quickly, efficiently and economically.

Do you have a cleaning problem, too . . . a place where deposits are causing a maintenance headache? Call Dowell. Skilled cleaning engineers are available for consultation at no obligation.

Other recent Dowell jobs:

In a large textile plant, the heating time required in kier heaters was cut one-third, following cleaning with Dowell Service.

•

Houdry catalyst cases cleaned by Dowell Service for a large refinery showed all tubes to be practically metal clean and orifices opened.

•

Thirty-three year old water well, cleaned by Dowell Service, showed increase from 64 to 130 g.p.m. with drawdown decrease of 27 feet.

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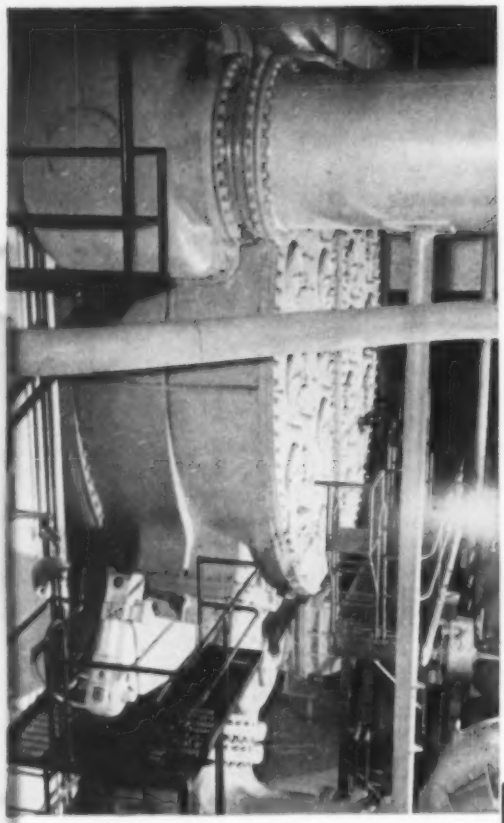
Long Beach, Oakland, Casper: Dowell Associate—International Cementers, Inc.

DOWELL

"SELF-CLEANING" CONDENSER

Eliminates 2 to 3 HOURS Daily Down-time



At Plant Atkinson, Harryat, Georgia, the Georgia Power Company draws circulating water from the Chattahoochee River. The inevitable sand, gravel, twigs and leaves used to clog condenser tubes and tube sheets in a matter of hours. Before the installation of a C. H. Wheeler Reverse Flow "Self-Cleaning" Condenser, it was a two- to three-hour job every day to remove anywhere from ½ to 2 yards of debris by hand. During this time, it was necessary to drop the load on the turbine to about half in order to operate against excessive back pressure.

Since September 5, 1949, when a C. H. Wheeler "Self-Cleaning" Condenser was installed, there hasn't been a single shut-down for cleaning. The Reverse Flow mechanism works flawlessly 24 hours a day, with 70,000 gallons per minute of river water passing through. The only cleaning is done by means of the electrically operated valves that reverse the flow of water through the condenser without interfering in any way with plant operation. This is done as often as necessary in a matter of minutes.

Through eliminating down-time for condenser cleaning, approximately *one month* of full capacity operation is added to the service of one of the four 60,000 KW turbo-generators in this 240,000 KW plant.

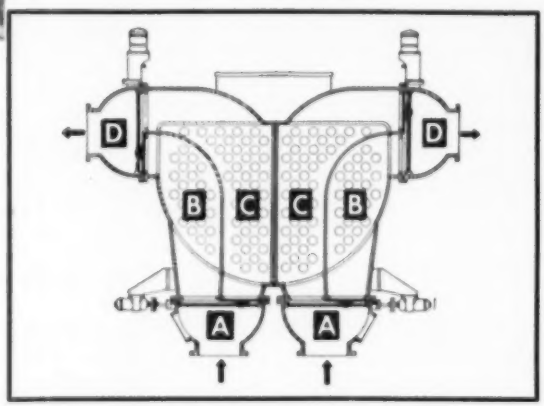
You, too, can benefit by C. H. Wheeler Engineering. Whether or not you need the self-cleaning Reverse Flow feature, it will pay you to "Investigate C. H. Wheeler Condensers before you Invest."

HERE'S HOW THE "REVERSE FLOW" PRINCIPLE WORKS →

Both halves of this Dual Bank Condenser work the same but independently of each other.

Left Side: Water enters divided water box at valve chamber A, with left port open. It flows through pass B to end of condenser, back through pass C and out through upper port of D.

Right Side: Flow is reversed. Valves at inlet A and discharge D are changed to permit water to flow through C and back through B in the opposite direction, then out through lower port of D.



C. H. Wheeler OF PHILADELPHIA

STEAM CONDENSERS—STEAM JET EJECTORS—COOLING TOWERS—VACUUM REFRIGERATION—HIGH VACUUM PROCESS EQUIPMENT—MICRO-PARTICLE REDUCTION MILLS—MARINE CONDENSERS & EJECTORS—DECK MACHINERY

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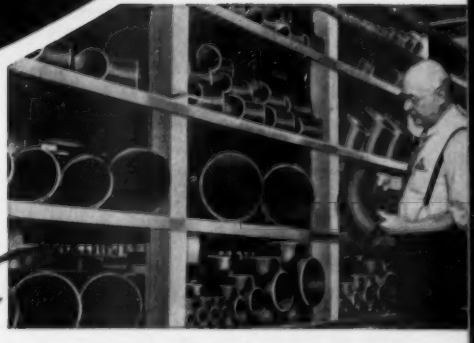
In all the world there's only one TUBE-TURN Welding Fitting as shown by this trade mark... the right mark for every need in welding fittings and flanges.

TUBE-TURN



More than ever, the services of your TUBE TURNS Distributor can be important to the smooth operation of your business.

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what results do you want from

Specific problems call for specific results. Here's proof that industrial plant management gets results as planned, with Hays automatic combustion control systems.

your combustion control system?

Increased efficiency? "Our basic reason for installing the Hays electric automatic combustion control was to obtain better efficiency. Our aim was more than reached . . . efficiency has climbed, attaining 79.3%." *Plant Engineer Manhattan Rubber Div., Raybestos-Manhattan, Inc.*

Low maintenance? "Our aim has always been to eliminate the need for maintenance wherever possible . . . and we are particularly pleased that maintenance has been "nil" with the (Hays) automatic combustion control system." *Chief Engineer, Kurth Malting Company*

Fuel savings? "Our fuel cost per pound of steam has dropped so much since we installed (Hays) instruments and combustion control, that fuel savings alone have been enough to pay for the investment in one year's operation." *Power Plant Chief Engineer, Vollrath Company*

Good CO_2? "The (Hays) controls in combination with our instruments make it possible to maintain high efficiency, as indicated by the 14½% average CO_2 obtained, and keep complete records of our operation." *Chief Engineer, Geo. Ziegler Company*

The Hays CORPORATION

MICHIGAN CITY, INDIANA, U.S.A.

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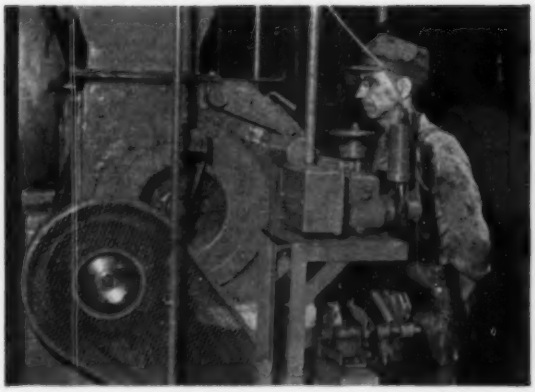


Rapid response to wide load swings? "We have made test runs using the Hays system, bringing the load rapidly up from 8,000 to 80,000 lbs. per hr. with excellent results. Fuel-air ratio was held at the desired value and CO_2 at 15%." *Chief Engineer of Power Plant, Bemis Bros. Bag Company*

How to get results

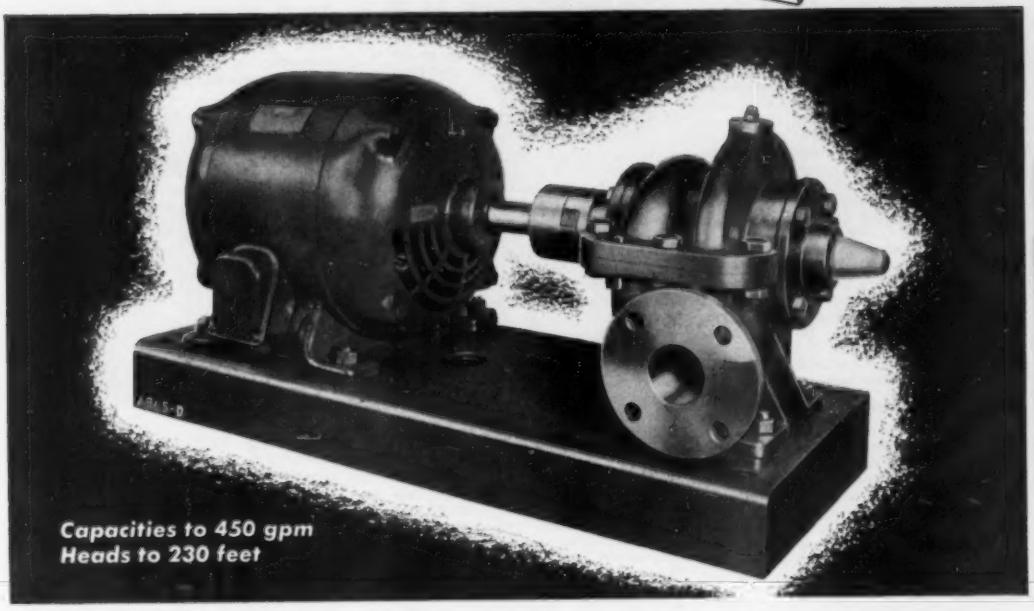
Hays application engineers will provide consultation on the special problems facing your plant. Through careful analysis, working with your actual operating conditions, they will recommend methods to achieve the results you want. Do you face any of these conditions?

Fuel savings—or special fuel problems
Plans to meet increasing load demand
Widely fluctuating loads
Improving efficiency in your plant
Problems in boiler and stoker maintenance
Meeting smoke abatement ordinances
Modernization of obsolete equipment
Accuracy of control in processing
Need for permanent records on combustion performance
Other . . .

Send for Bulletin No. 49-605 which describes how Hays equipment serves industry. For specific preliminary recommendations, without obligation, send us a brief statement of your combustion problem. Hays Corporation, Michigan City 7, Ind.

We've Simplified

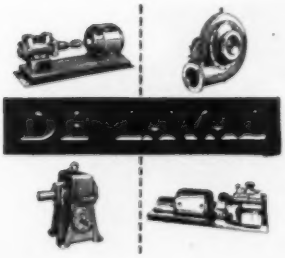
THE ALREADY SIMPLE CENTRIFUGAL PUMP



We've eliminated the stuffing boxes
The mechanical seal used in the new GS Pump never requires adjustment and never leaks. It is simple, effective and proved.

We've eliminated lubrication
Like modern, electric motors, the new GS Pump has *permanently* lubricated ball bearings.

We've eliminated field repairs
For the first time, you can let the factory do your service work. If repairs ever are necessary you can obtain a complete new rotor assembly or factory rebuilt and guaranteed pump through our Service and Exchange Plan. Or, if you wish to do your own service work, you will appreciate the fact that this pump is built with a horizontally split casing and interchangeable parts are carried in stock.



Send for Catalog 10-20-G

DE LAVAL STEAM TURBINE CO.

Trenton 2, N. J.

GP-20

NEW EQUIPMENT NEWS

WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other information desired. For ease in making requests use the no-obligation, postage-paid card pages 35-36.

1—WATER TREATMENT

Is developed to eliminate foaming and boiler water carryover

Concentrol is announced as a special treatment which eliminates foaming and boiler water carryover due to high alkalinity, dissolved solids, suspended solids or any combination of them. It is described as a surface active agent of the polyalkylene glycol group and functions by effecting a rapid change in surface tension of steam bubbles to permit coalescence of small steam bubbles of larger size. Company explains that this results in the formation of unstable bubble films which break readily upon reaching the steam disengaging surface of the boiler.

Concentrol comes in several formulations, some of which contain selected tannins to condition boiler water sludge and suspended matter and maintain them in a fluid, non-adherent form. Concentrol may be fed through feedlines, it is pointed out, and when fed continuously will help inhibit feedline deposits. The Bird-Archer Co.

2—ANNUNCIATOR

Has large window areas for readability from distances up to 60 ft

Well adapted for use in boiler and control rooms, the Type ANJ Annunciator has 2¾ by 9¾ in. window areas with lettering on a heavy photographic negative held between glass sheets, which show up as large clear white letters against a sharp black background.

The annunciator is for surface or

flush mounting and may be used to supervise liquid levels, electro-mechanical movements, temperatures, pressures or vacuums, rotary movements, pilot flames, etc. Standard circuit provides facilities for simultaneously testing all lamps, relays, and interconnecting circuits; silencing remote audible alarm with a common silencing switch, and resetting relays with common reset switch. The Autocall Co.

3—BRONZE GLOBE VALVE

Features guided disc design and fast roller action to distribute wear

A rapid-action bronze level gate valve, the new Swingtite has ball and socket design double discs which adjust readily to seat surfaces. The guide rims on these discs rotate freely on guide tracks cast in the body, as the valve opens or closes.

Company points out that this roller action provides a self-cleaning and polishing effect and also distributes the wear. The rolling disc and track construction is used for accurate seating with continual tight closure.

The Swingtite is rated for 125 lb steam service, 300 lb cold oil, water and gas, and is made in ½ to 2 in. sizes. It's especially adaptable for use in oil refineries, textile, chemical and food industries. Jenkins Bros.

4—GROUND TESTER

Measures earth resistance of ground connections; has own generator

The new CVM Megger Ground Tester is intended to provide a dependable and easy way to ascertain whether the resistance to earth of man-made grounds is low enough to insure their correct operation and to minimize the dangers of lightning.

Complete with generator, this modern set is independent of other power supply. Its terminal arrangement uses two switches which short circuit the terminals for 2, 3 and 4 terminal tests. The instrument has two scales with well proportioned markings. Two ranges are available: 0 to 40 and 0 to 200 ohms; 0 to 100 and 0 to 500 ohms. James G. Biddle Co.

5—ABSORBER UNIT

Is easily installed in pipe lines to absorb noise and vibration

The Soundzorber is a specially constructed rubber pipe used as a flexible connection between the pump and the pipe line. It is adaptable for use in water pumps, water systems, boiler systems, air conditioning systems—wherever liquids are pumped and pipe line flexibility is required.

Standard flanges on each end of the pipe are imbedded in the rubber. To install, just bolt on to flange of the machine. There's no metal contact between pump and piping system. The Soundzorber is designed for working pressures to 250 psi, and to withstand temperatures to 250 F. Available for pipes from ½ to 14 in. dia. Finn & Co.

6—RUGGED REFRACTORY

Is now available in fire brick; grain form and ramming mix to come

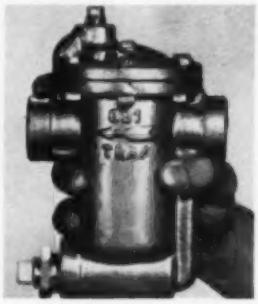
Mullite ($3Al_2O_3.2SiO_2$), a tough crystalline compound long known as a durable refractory material for severe furnace conditions, is being volume produced in the form of Allmul Firebrick. The ingredients of Allmul are so proportioned as to form a high percentage of mullite crystals with no free silica, company explains, and the small amount of excess material consists mainly of carborundum, which also has high refractory properties.

The melting point of Allmul is given as 3335 F, and it is said to possess remarkable resistance to spalling. Other advantages credited to the new refractory are its low first cost, due to mass production, and the reduced furnace maintenance it affords. The Babcock & Wilcox Co.

7—STEAM TRAP

Small inverted-bucket type, has brass strainer built into body

The No. 881 is a side-inlet, side-outlet trap for draining smaller sized equipment producing relatively small amounts of condensate—sterilizers, laundry presses, jacketed kettles, unit



heaters, soap tanks, steam headers. This new trap is larger than company's 880 introduced two years ago to meet requirements for a small trap with integral strainer, and has been developed for increased pressure and capacity applications.

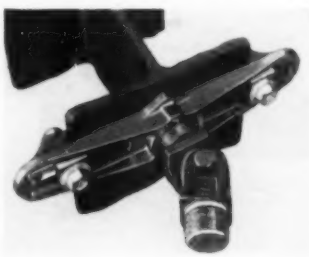
The 881 is for ½ or ¾ in. pipe connections, 250 psig operating pressure. Its hot condensate capacity is 769-1060 lb-hr, height 7-1/16 in., weight 6 lb. Armstrong Machine Works.

8—ADJUSTABLE BEAM CLAMP

For suspending overhead mounted equipment from structural members

This heavy duty clamp is designed to suspend heaters, motor platforms, lighting fixtures and other equipment from structural members of the building. It supports loads up to 1500 lb, company states, and is easily attached. Installation and adjustment are accomplished by two bolts and nuts; also clamp is tapped for a 1¼ in. pipe connection.

The clamp is cast malleable iron, cadmium plated for corrosion resistance. It can be attached to standard I, inverted T or H beams as well as trusses and girders consisting of angles



Like this record of low-cost maintenance?

make it yours
with dependable quality

CRANE VALVES

No. 960 Crane Brass Pressure Regulator for steam or air. Literature on request through your Crane Branch or Crane Wholesaler.

A CASE HISTORY FROM CRANE FILES

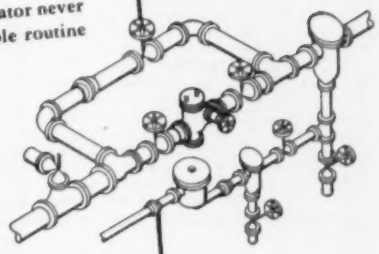
PROBLEM: To choose a pressure regulator that would assure a steady, unvarying steam supply to cooking kettle for an exacting brewing process.

WORKING CONDITIONS: Regulator subject to continuous operation 24 hours per day. Main steam supply at 100 psi to be constantly reduced and maintained at 30 psi.

SOLUTION: Crane No. 960 Brass Pressure Regulator. (*Former model with integral non-renewable cylinder.*)

RESULT: For 16 years, throughout its lifetime, the Crane 960 Regulator never failed, never faltered, never required more than prescribed simple routine servicing.

Replaced with new Model 960 Crane Pressure Regulator. With all wearing parts renewable, it will virtually never wear out. Now in service 18 months; operating cost: zero.



A typical example of the long life and low-cost maintenance that make Crane Quality the best value in all types of valves. That's why...
More CRANE VALVES are used than any other make

CRANE

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

or channels back-to-back. Being adjustable it will fit structural members from 4 to 8½ in. wide. It can be equipped with an adjustable angle fitting to provide for vertical suspension from sloping or arched roof members, and to permit angle mountings from wall posts. Company points out that use of this clamp eliminates need for drilling holes in beams, girders and posts. Thompson Electric Co.

9—SAMPLE COOLER

Is available for cooling boiler and boiler feedwater samples

Suitable for cooling samples required for controlling chemical and refinery processes and laboratory use, this is a stainless steel shell and tubular coil type heat exchanger. Of all welded construction it's designed so all connections are external to both cooling coil and jackets. It features company's counterflow principle to make possible the cooling of liquid samples to temperatures approaching those of the inlet cooling media.

Designed for 1500 psi and temperatures of 600 F on the cooling coil side and 150 psi on the jacket side, it is 3⅜ in. OD and 11⅛ in. long, and made in ¼ and ½ gpm capacities. Worthington Pump and Machinery Corp.

10—SPLASHPROOF MOTORS

For outdoor installation, come in both horizontal and vertical types

After extensive research and testing, manufacturer announces the development of this line of motors for installation outdoors without external protective covering. The horizontal type can be placed on a simple foundation or the base of the driven machine. Its ventilating air inlet openings are located on the sides of the motor and discharge between the feet.

The vertical motor is normally mounted on top of vertical pumps, well up from the ground, permitting air intake through bottom of motor side discharge. In this, as in the horizontal type, design permits wind-blown rain to blow through outer chambers and by-pass the interior of the motor. Elliott Co.

11—CONTROL VALVE

Air operated, for regulating flow of steam, water, oil or gas

The Metaflow is a diaphragm operated valve that's small, sturdy, lightweight and low priced. It's suitable for control applications where pressure differential doesn't exceed 75 psi, and available in sizes ½ through 2 in. Body is bronze, with direct or reverse acting or three-way standard valve, or packless valve. The packless type is intended to prevent leakage of inflammable or harmful liquids and to provide vacuum protection. The Powers Regulator Co.

12—SWITCHBOARD INSTRUMENTS

Have cover design which permits shadow-free illumination of scales

A protruding convex-type glass cover which permits the scale to be mounted flush with the front of the case is the feature of this new line of 4¼-in., long-scale switchboard instruments, company's Types AB-18 (a-c) and DB-18 (d-c). This is intended to eliminate scale shadows from overhead lighting.

The new instruments are for general switchboard service on both large and small equipment, such as control stations. Many of these instruments can be mounted on a panel 24 in. sq. They are mechanically interchangeable with company's established line of long-scale instruments and available in generally used ratings for a-c and d-c circuits. Models include d-c ammeters and voltmeters and a-c ammeters, voltmeters, wattmeters, frequency meters, power factor meters, synchroscopes. Meter and Instrument Div., General Electric Co.

13—TELESCOPE

For observing distant water columns, gages and other instruments

With this high powered prismatic scope you can read water columns 100 ft away, company states. For use in combination with a universal mounting

bracket, the bracket holds the telescope steady but permits ready adjustment to any angle. Scope with coated optics costs $49.50; mounting bracket with screw base is $12.50, with clamp base it costs slightly more. The Kollmorgen Optical Corp.

14—ALL PURPOSE VIBRATOR

Features simplified design for reduced maintenance, easy operation

Company's Type F Air Vibrator has been redesigned so it incorporates only five major parts—mounting base plate, housing, spring, piston and head. The assembly is held by four longitudinal body bolts and special stop lock nuts.

Built to handle sand, gravel, cinders, cement, coal, lumpy or powdered chemicals, the Type F is suggested for use in installations where stubborn materials plug up or arch in chutes, hoppers, bins, screens or storage tanks. The new design improvements are expected to reduce wear to a minimum. The Cleveland Vibrator Co.

15—SPREADER-TYPE STOKERS

With traveling grate; for large industrial plants, central stations

These Centrafire Stokers have a fuel-burning capacity range from 30,000 to over 350,000 lb of steam per hr, and are built in sizes suitable for standard boilers within this range.

Coal is spread by a hydraulic motor-driven overthrow rotor so it falls evenly over the entire length of the fuel bed. The forward moving traveling grate discharges ashes continuously at the front and air seals permit ample opening between grate and bottom of front wall for the discharge of ash from high ash coal.

Coal is fed to each rotor by two long-stroke constant velocity rams. Company points out that the complete integrated hydraulic drive system for fuel feed, fuel distribution and grate drive provides a synchronized drive with independent control and adjustment for each element. Optimum fire bed condition is credited to the method of varying distributing rotor speed automatically in relation to the fire bed resistance on front and rear sections of the stoker. Westinghouse Electric Corp.

16—AXIAL FANS

Utilize aerodynamic design principles for industrial cooling jobs

Aeromaster Fans are applicable to engine jacket water coolers for natural gas, gasoline or diesel engines; vertical discharge units; oil field and power utility air coolers and water coolers, and large air conditioning systems. Their increased efficiency is said to make possible either a greater cooling capacity with the cooling unit currently in use, or an equal cooling capacity with a smaller horsepower consumption.

Fan diameters range from 6 to 20 ft; the largest size delivers 500,000 cfm and is designed for continuous open-air operation. Aeromatic Propeller Dept., Koppers Co., Inc.

17—FLOATLESS UTILITY PUMP

Is general purpose unit for permanent or emergency installation

This pump is suggested for the quick and complete removal of water from boiler rooms, transformer and cable vaults, draining vats and tanks, elevator pits and other underground utility installations. It operates completely submerged, company states.

The entire unit is of corrosion-resistant bronze construction and it is operated automatically by a liquid level switch control. It can be operated manually, however, with the through cord switch. Manual control lets the operator turn on the pump instantly at any depth of water. The through cord switch can be snapped to automatic position and pump will operate unattended and turn off automatically when it draws air. Pump is compactly designed for installation in close quarters. Kenco, Inc.

18—POWER SUPPLY

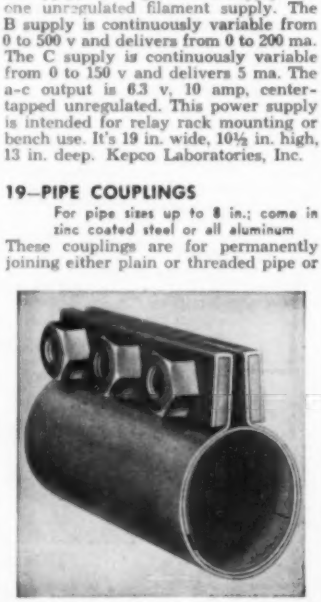
Features good regulation, low ripple content and output impedance

The Model 515 features one regulated B supply, one regulated C supply and one unregulated filament supply. The B supply is continuously variable from 0 to 500 v and delivers from 0 to 200 ma. The C supply is continuously variable from 0 to 150 v and delivers 5 ma. The a-c output is 6.3 v, 10 amp, center-tapped unregulated. This power supply is intended for relay rack mounting or bench use. It's 19 in. wide, 10½ in. high, 13 in. deep. Kepco Laboratories, Inc.

19—PIPE COUPLINGS

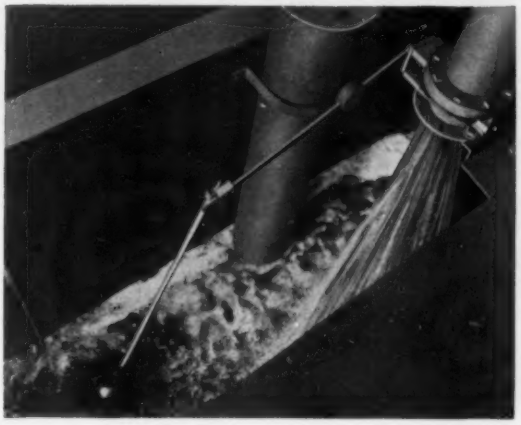
For pipe sizes up to 8 in.; come in zinc coated steel or all aluminum

These couplings are for permanently joining either plain or threaded pipe or



R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



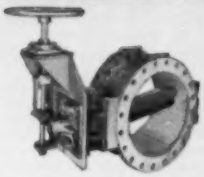
R-S FLOAT VALVE for Sewage Service

The R-S Heavy Duty Direct Action Float Valve controls the water level in a wet well of a sewage treatment plant at Quakertown, Pennsylvania. Illustration shows valve approximately 25% open. At the high level, practically drip tight shut off is obtained with metal-to-metal seat. The adjustable float connection keeps the float away from the area of turbulence.

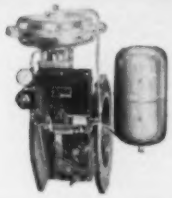
R-S Valves are used in air, gas, liquid, steam and semi-solid service for the shut off and regulation of volume and pressure, pressure relief, liquid level control, back pressure, water hammer, steam hammer, constant differential pressure, output control of pumps, fans, engines, turbines and automatic combustion. Suitable for service in the temperature range from minus 300°F to plus 2000°F. 2 to 2500 psig.

Specify R-S Valves for simplified control and shut off. Consult with your local R-S Valve Engineers or write direct.

R-S PRODUCTS CORPORATION
Wayne Junction • Philadelphia 44, Pa.



No. 700—20-inch 50-pound Cast Iron Valve with rubber seat, Type B-8934, for positive 100% shut-off. Heavy duty handwheel control with threaded reach rod. Type B-9469.



No. 781—Fourteen-inch Heavy Duty Cast Iron Valve with 125-pound American Standard flanges and drilling. Mounting bracket, crank arm, reach rod and linkage together with springless diaphragm top including positioner, gauge and an auxiliary tank as an integral part of the unit. Should all air fail, pressure in the tank will stroke the valve. Note the bronze bushings in bracket through which the air motor shaft passes.

No. 780—Eight-inch Off Center Valve for control of 15 psig saturated steam with 1 psi drop. Series 15, 150 - pound American Standard raised face flanges. Double crank arm with adjustable weights for accurate setting. Cylinder is not an actuator but simply a dash pot. Note 2-inch flanged outlet for overload relief.

No. 782—Heavy Duty Wafer Type Valve, rubber seated, 5° angle seated vane with enclosed gear reduction drive.

Note that there is plenty of room to easily remove the gland and repack the stuffing box.

a combination of the two. Compression type couplings, they are designed to hold the entire surface of the joint in compression. They are applied with socket or crescent wrench and give each joint the advantage of a pipe union.

According to company, these couplings are used successfully on oil, gas, water, steam, air, sewage, irrigation and conduit lines. Rubber base gaskets are standard, but gaskets of cork, fiber glass and Neoprene are available. Morris Coupling and Clamp Co.

20—LONG SWEEP VALVES

Angle type, for use on slurry service, to produce minimum turbulence

The 7000S Series Flo-Tested Long Sweep Angle Valves are designed primarily to produce minimum turbulence in the flow through the valve and are suggested for use where solids in suspension would tend to plug many types of control valves.

The valve body is described as a long radius bend. Carbon and stainless steels are standard, but body can be fabricated from any type of pipe which can be bent and welded, company states. Construction features which contribute to reduced turbulence include a streamlined valve plug which offers minimum flow resistance to fluid passing through, and is extra long to assure ample guiding. Plug is of the high lift type. The seat is actually designed as a section of a Venturi throat to afford minimum turbulence in the seat section. Valves can be provided in any size from 2 to 6 in. The Hammel-Dahl Co.

21—ELECTRONIC RECTIFIERS

Fully enclosed units for floor or wall mounting, convert a-c to d-c

These electronic units can be supplied with constant or adjustable d-c output voltages in ratings up to 230 v, 87 amp. The adjustable voltage units provide a range of from 60 to 100 per cent of output voltage.

Electronic tubes and other components are rated conservatively, and separate compensating adjustments for filament voltages are incorporated. Rectifier units are designed for operation from 115/230 or 230/460 v, single-phase or three-phase. Westinghouse Electric Corp.

22—LOW-LEVEL BOILER ALARM

"Sings" when boiler water level reaches predetermined low point

The Micro-Thermal Low-Level Boiler Alarm consists of a $2^3/_8$ in. expansion tube with its inner end connected to the lower end of the water column on the boiler, and its outer end connected to the upper part by $^1/_4$ in. copper tubing. Water rises and lowers above this tube, and when the water level reaches the low point the increased heat in the tube actuates a double-throw microswitch. One throw is connected to an alarm—buzzer, bell, howler etc.—and the other may be connected to a boiler fuel cut-off arrangement, a solenoid valve in the fuel line.

The switch will throw on and off on a temperature change of only 5 deg F, says manufacturer, who points out that the usual difference of 100 deg or so between temperature of boiler and that of water column permits extremely sensitive response. The alarm switch, housed in a metal box, can be connected to a single 6-v dry cell battery. J. A. Campbell Co.

23—CONTROL DRIVE

Can be "tuned" to the requirements of a special application

Here's an air-operated drive designed to permit paralleling the characteristics of a driven device with those of other equipment to secure a unified system. The drive consists of a double-acting air cylinder, a positioning relay and a manual operating wheel or lever. It's protected by a complete enclosure.

The positioning relay—which provides the characterizing feature—incorporates a cam and the cam's shape determines the relation of control drive position to control loading pressure. Three cams come with each drive and you can use them interchangeably to obtain positions proportional to the first power (straigth line), square, or square root of control pressure. Cam shapes can be modified for special relationships.

The drive is claimed to require only 0.10 psi change in control loading pressure to deliver full supply pressure to piston. Two sizes are available—one for torque requirements of 280 to 400 ft-lb and the other for requirements up to 1500 ft-lb. Bailey Meter Co.

24—ELECTRIC STEAM BOILER

Has working pressure up to 50 psi; comes in sizes from 3 to 25 boiler hp

The Speedyelectric 400 can be operated on 220, 440 or 550 v, single or polyphase. It's built to ASME specifications and carries the stamp of the National Board of Boiler and Pressure Vessel Inspectors. It has many applications, especially in process heating of steam using equipment, and is described as economically priced. Livingstone Engineering Co.

25—RECORDER-CONTROLLER

For applications where a record of controlled temperature is desired.

The Record-O-Stat is a proportional action controller for air or liquid temperatures and may be operated as direct or reverse acting. Sensitivity of control is adjustable by varying throttle range, which is adjustable to full chart range. For exacting applications an automatic reset feature is available to coordinate deviation in control with thermal lags inherent to system being controlled.

Increased sensitivity of the measuring bulb is credited to fact that entire measuring system is liquid filled—the relatively low pressure and thin bulb walls improve conductivity. Five standard 12-in. charts with ranges from 0 to 250 F are available; measuring elements with charts for operation at other ranges between 125 and 400 F may be ordered.

Copper bulb measuring element is furnished plain, with union, or with union and socket. Capillary tubing is provided in lengths from 5 to 200 ft. Unit is housed in corrosion resisting aluminum alloy. Johnson Service Co.

26—GAS-FIRED UNIT HEATERS

Burn either natural, manufactured, mixed or liquid petroleum gas

The first gas unit heaters manufactured by this company since the war feature "built-like-a-boiler" design details. The heat generator includes burner heads and mixing tubes of one-piece cast iron construction. Burners, pilot and control valves are combined in one drawer-type assembly. A high limit switch prevents overheating; both gas main and pilot light cut off automatically in case of failure. The fan may be controlled by a room thermostat.

Heart of the new heater is the "Torrid Tube" exchanger. Its generously sized steel tubes are rolled into heavy end sheets, boiler tube style, and fortified with additional outer and inner rolled flanges. A built-in draft diverter allows back drafts and updrafts to bypass burner assembly without affecting burner operation.

Heaters come in seven sizes with capacities from 50,000 Btu per hr to 210,000 Btu per hr input and 700 to 2700 cfm. The Trane Co.

27—ENCLOSED BREAKERS

Individually mounted, for use wherever there is low voltage current

These are company's Types G-25 and G-50 low voltage air breakers, previously available only as bare breakers or in metal enclosed switchgear. The stationary mounted breaker has a sheet steel housing that encloses circuit breaker and cable connections. Enclosure's front portion has removable hinged panel, ventilating louvers, latching mechanism, flash barriers.

The rear or cable entrance box can be separated from breaker housing and includes removable cover plates for easy connection and cover plates with different sized knockouts for incoming and outgoing cables.

Described as particularly effective where frequent operation is expected, these breakers are suggested for protecting lighting loads and small transformers, across-the-line starters, as back-up protection for motor starters, and as main feeder breakers on systems with a-c voltages of 600 and below, fault currents of 25,000 to 50,000 amp and continuous currents from 35 to 1600 amp. Allis-Chalmers Mfg. Co.

28—SMOKE DETECTOR

Is designed for installation in air conditioning duct systems

Duct systems have the inherent danger of spreading smoke quickly throughout a building, and the purpose of this photoelectric detector, Type A28E, is to detect the presence of smoke as soon as it appears in the duct system. Auxiliary relays are available for automatically turning off blowers, closing automatic shutters and signaling the maintenance department.

Detector is supplied with company's Type L30R light source, and designed for mounting on opposite side of the duct. Among features stressed for the system are a sensitive photoelectric circuit and a tamper-proof sensitivity control. It has an operating range from 5 to 30 ft, uses a supply voltage of 115 v, 60 cycles a-c. Photoswitch Inc.

SUNVIS 900 OILS

are good for the life of your turbines

Continuous, efficient turbine operation. That's what Sunvis 900 Oils provide. They do not form the sludges, gums, resins, varnishes, or corrosive products that clog lines and attack precision-fitted parts. They do not permit rust formation, and they prevent the corrosion that pits and eats away metal.

Quality-wise, they are unsurpassed. Experience shows that under normal operating conditions Sunvis 900 Oils are *good for the life of your turbines*. For complete information, call or write your nearest Sun Office.

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SUN PETROLEUM PRODUCTS

"JOB PROVED" IN EVERY INDUSTRY

SUNOCO

POWER PLANT Construction News

Mobile, Ala.—Hollingsworth & Whitney Co., Mobile, plans enlargement of power plant at local pulp and paper mill, with installation of new equipment for increased output. Program will be carried out as part of a general expansion project at mill, with several additional buildings and machinery installation for considerable advance in present capacity. Entire development is reported to cost about $8,500,000. Work is scheduled for completion in 1951. Main offices of company are at 60 Batterymarch St., Boston, Mass.

Camden, Ark.—Board of Supervisors, Ouachita County, Camden, plans boiler house for central-heating service at new county hospital, consisting of several buildings. Cost $1,500,000. Proposed to begin work soon. Bruce R. Anderson, Wallace Bldg., Little Rock, Ark., is architect.

Anaheim, Calif.—Neville Co., Neville Island, Pittsburgh, Pa., synthetic resins, solvents, etc., plans boiler house at proposed new plant on 12-acre tract of land recently acquired at Anaheim. It will comprise a main processing and production building and several auxiliary units. Entire project is reported to cost in excess of $1,000,000.

Folsom, Calif.—Bureau of Reclamation, Denver Federal Center, Denver, Colo., plans early call for bids for three 74,000-hp, vertical-shaft hydraulic turbines, for installation in hydroelectric power plant at Folsom, Central Valley project.

Los Angeles, Calif.—American Can Co., Fibre Container Division, 4815 Santa Fe Ave., Los Angeles, fibre cans and containers, plans boiler house at new plant on 35-acre tract of land in Wilmington district. It will comprise a main one-story unit and several auxiliary structures. Entire project is reported to cost approximately $2,000,000. Main offices are at 250 Park Ave., New York, N. Y.

Los Angeles, Calif.—Southern California Edison Co., 601 West Fifth St., has preliminary plans under way for new steam-electric generating station in Whittier Narrows district, Los Angeles County, where tract of over 120 acres of land has been selected. Details of installation will be determined at early date, including turbine-generators, high-pressure boilers and auxiliary equipment. Entire project estimated to cost in excess of $35,000,000. Application for permission to proceed with construction has been made to Los Angeles County Regional Planning Commission.

San Diego, Calif.—San Diego Gas & Electric Co., 861 Sixth Ave., plans further expansion in Silver Gate steam-electric generating station, where extensions are now under way. New work will include installation of a turbine generator of about 60,000-kw rating and auxiliary equipment and is scheduled for completion late in 1952. Cost estimated close to $8,000,000, including transmission line extensions and other operating facilities.

San Francisco, Calif.—Pacific Gas & Electric Co., 245 Market St., plans expansion in steam-electric power plant at Moss Landing or Contra Costa, Calif., still to be determined, during next 36 months, with work to include installation of three 100,000-kw turbine-generators and accessories, high-pressure boilers and auxiliary equipment. Order for generator units has been placed and contracts for other required equipment will be made in near future. Entire project will represent a reported investment of about $50,000,000.

Washington, D. C.—Expansion of Potomac Electric Power Co., 929 E St., N.W., recently noted in these columns, will be carried out at generating station at Benning, D.C., with installation of a new 60,000-kw turbine-generator unit, and auxiliary equipment. Cost reported about $8,000,000, including transmission line extensions. Work will proceed at once, with completion scheduled in 1952. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer.

Keystone Heights, Fla.—Clay Electric Cooperative, Inc., Keystone Heights, plans extensions in oil engine-operated electric power plant, with installation of two new Diesel engine-generator units and auxiliary equipment. Fund of $1,200,000 has been arranged through Federal aid for this and line construction. Proposed to begin work at early date.

Pensacola, Fla.—Gulf Power Co., 8 North Palafox St., plans expansion in steam-electric generating station, with installation of 30,000-kw turbine-generator unit, condenser, high-pressure boiler and auxiliary equipment. Cost close to $4,500,000, including transmission lines and other operating facilities. Work will be carried out at early date.

St. Petersburg, Fla.—Florida Power Corp., 101 South 5th St., plans expansion in generating plants during next 42 months, to provide for an increase of 120,000-kw in present capacity. Cost estimated about $20,000,000. This will be included in an expansion and improvement program to cost approximately $60,000,000 during period noted, comprising power substations, transmission and distribution lines, and other operating facilities.

Winter Haven, Fla.—Polk Packing Association, Inc., and Snively Groves, Inc., Winter Haven, affiliated, citrus fruit packing and processing, plan boiler plant in connection with rebuilding of factories, destroyed by fire several months ago. Several one-story buildings will be erected, with machinery and facilities for large output. Entire project is reported to cost about $1,500,000. Work will proceed at once.

Atlanta, Ga.—International Paper Co., Single Service Division, 220 East 42nd St., New York, N. Y., plans boiler plant at new paper-converting factory on 10-acre tract of land at Atlanta, recently acquired, for production of paper milk cartons. Work will begin soon with completion scheduled next spring. Entire project is reported to cost about $500,000.

Newnan, Ga.—Georgia Power Co., Electric & Gas Bldg., Atlanta, Ga., has authorized expansion in Yates steam-electric generating station near Newnan, with installation of new 100,000-kw turbine-generator, making third such unit at plant, and auxiliaries. Cost reported close to $10,000,000. Work is expected to begin in near future.

Thomson, Ga.—Deering, Milliken & Co., 240 Church St., New York, N. Y., textile products, plans boiler plant at proposed new rayon weaving mill at Thomson. It will consist of a main one-story building, and several auxiliary structures. Entire project is estimated to cost about $2,000,000. Daniel Construction Co., 429 North Main St., Greenville, S. C., is engineer, and will be in charge of erection.

Grandview, Idaho—Idaho Power Co., 1220 Idaho St., Boise, Idaho, has plans in progress for new hydroelectric generating plant on Snake River, near Grandview. It will have a rated output of 90,000-kw, divided into three 30,000-kw hydraulic turbine-generator units. Project is reported to cost about $18,500,000, including transmission system. Work is scheduled to begin at early date, with completion in 1952.

Priest River, Idaho—U. S. Army, Corps of Engineers, Office of District Engineer, 4735 East Marginal Way, Seattle, Wash., plans hydroelectric power development at Albeni Falls, near city of Priest River, on Pend Oreille River, with power dam 700 ft long and 90 ft high. Estimates of generating capacity and details of project are now being determined. Proposed to begin work next year. Entire project is estimated to cost approximately $31,000,000.

Marion, Ill.—Board of Directors, John E. Giles, president, Marion Memorial Hospital, Marion, plans boiler house for central-heating service at new multi-unit hospital. Entire project estimated to cost about $900,000. William B. Ittner, Inc., Board of Education Building, 911 Locust St., St. Louis, Mo., is architect and engineer.

Indianapolis, Ind.—Chrysler Corp., 341 Massachusetts Ave., Detroit, Mich, plans power house at new plant on 150-acre tract of land near Indianapolis, recently acquired, for production of gears and transmission systems for automobiles. Project will comprise a main one-story building, over 600,000 sq ft floor space, and several auxiliary structures. Cost reported close to $6,500,000. Albert Kahn Associated Architects & Engineers, Inc., New Center Bldg., Detroit, Mich., is architect and engineer.

Kansas City, Kan.—Ford Motor Co., Dearborn, Mich., plans power plant at proposed new passenger car and motor truck assembling plant on 500-acre tract of land now being secured in vicinity of Kansas City. It will comprise several large one-story units, and is reported to cost close to $25,000,000, with equipment. Proposed to begin work this fall and to have plant ready for service early in 1952.

Lawrence, Kan.—Westvaco Chemical Division, Food Machinery & Chemical Corp., 405 Lexington Ave., New York, N. Y., plans boiler house at proposed new factory at Lawrence, for production of soluble phosphates, consisting of several one-story buildings, to be equipped for large output. Entire project will cost about $3,500,000. Bechtel Corp., 220 Bush St., San Francisco, Calif., is engineer, and will be in charge of construction.

Louisville, Ky.—Louisville Gas & Electric Co., 311 West Chestnut St., has authorized expansion in local Paddy's Run steam-electric generating station, with installation of new 60,000-kw turbine generator and auxiliary equipment. Cost reported about $8,500,000, including extension in transmission lines and other operating facilities.

Louisville, Ky.—Philip Morris & Co., Ltd., 119 Fifth Ave., New York, N. Y., plans steam-generating plant at proposed

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new cigarette factory at Louisville, where site is being acquired. It will consist of several one- and multi-story buildings, with processing and other equipment for large capacity. Entire project is reported to cost in excess of $10,000,000. Work is expected to begin soon.

Wiscasset, Me.—Central Maine Power Co., 9 Green St., Augusta, Me., plans expansion in steam-electric generating station at Wiscasset, known as Mason power plant, with installation of new 70,000-kw turbine-generator, high-pressure boiler and auxiliary equipment. Cost reported about $6,000,000. Proposed to carry out program soon.

Hattiesburg, Miss.—Hercules Powder Co., Naval Stores Department, Delaware Trust Bldg., Wilmington, Del., plans boiler house at new plant at Hattiesburg, for manufacture of insecticides of chlorinated-camphene character. It will consist of a main building for processing and general production, and several auxiliary units. Entire project reported to cost close to $1,500,000.

Silver Bow, Mont.—Victor Chemical Works, Inc., 141 West Jackson Blvd., Chicago, Ill., agricultural and industrial chemicals, plans power house at proposed new plant for production of elemental phosphorus at Silver Bow, where site has been selected. Electric furnaces will be installed for reduction service. Plant will consist of several large structures, and is reported to cost $5,000,000.

Omaha, Neb.—Quaker Oats Co., 141 West Jackson Blvd., Chicago, Ill., cereal products, etc., plans boiler house at proposed new branch plant at Omaha for manufacture of furfural and other chemical specialties. It will comprise a main building for processing and general production, and several auxiliary units. Entire project is reported to cost close to $1,000,000.

Sidney, Neb.—Ohio Oil Co., Findlay, Ohio, plans boiler house at proposed new natural gasoline plant near Sidney. Project will comprise a large processing unit and is estimated to cost in excess of $500,000. Work is scheduled to be placed under way soon.

Albany, N. Y.—Niagara Mohawk Power Corp., 300 Erie Blvd. West, Syracuse, N. Y., has plans under way for proposed new steam-electric generating plant on Hudson River, vicinity of Albany, to be equipped for initial rated capacity of 160,000-kw. Cost reported over $20,000,000, with turbine-generators, high-pressure boilers and auxiliary equipment. Planned to begin work soon, Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer and will supervise construction.

East Williston, N. Y.—Board of Education, Union Free School District, East Williston, plans central-heating plant in new school on Willets Rd. Entire project is estimated to cost about $1,200,000. F. P. Wiedersum, 240 Rockaway Ave., Valley Stream, N. Y., is architect.

Syracuse, N. Y.—Niagara-Mohawk Power Corp., 300 Erie Blvd., West, Syracuse, has secured permission from Federal Power Commission, Washington, D. C., for a hydroelectric power development on Sacandaga River, Saratoga County, N. Y., comprising power dam 1650 ft long and 112 ft high, power station, switching station, and other operating facilities. Proposed to begin work soon. Project is estimated to cost about $5,600,000.

Acme, N. C.—Riegel Paper Corp., 342 Madison Ave., New York, N. Y., waxed, glassine and other processed papers, is considering construction of new pulp mill near Acme, where tract of land is being secured. It will comprise a number of buildings equipped for a capacity of 20 tons per day. A boiler plant will be built. Entire project is reported to cost in excess of $10,000,000.

Franklin, N. C.—Nantahala Power & Light Co., Franklin, has secured authority from Federal Power Commission, Washington, D. C., to construct and operate a hydroelectric power plant on East Fork of Tuskasegee River, Jackson County, N. C., including power dam, generating station, switchyard and auxiliary structures. Project is estimated to cost $1,225,000. Work is scheduled to begin soon.

Lumberton, N. C.—Carolina Power & Light Co., 336 Fayetteville St., Raleigh, will begin work soon on addition to steam-electric generating plant at Lumberton, with installation of new 100,000-hp turbine-generator unit and auxiliary equipment. Completion is expected late in 1952. Cost reported over $7,500,000, with transmission line extensions and other operating facilities.

Raeford, N. C.—Robbins Mills, Inc., Robbins, N. C., rayon fabrics, plans steam power plant at new rayon weaving mill at Raeford. Mill unit will approximate 300,000 sq ft floor space. Entire project will represent a reported investment of about $6,000,000. Work will begin at early date and is expected to be completed next spring.

Cleveland, Ohio—Cleveland Electric Illuminating Co., Illuminating Bldg., has plans in progress for first unit of proposed new steam-electric generating plant at Eastlake, near Cleveland. Installation will consist of turbine-generators with capacity of 125,000-kw, high-pressure boilers, and auxiliary equipment, switchyard and other operating facilities. Cost estimated about $25,000,000. Completion is scheduled early in 1953.

Niles, Ohio—Ohio Edison Co., 47 North Main St., Akron, Ohio, has plans under way for new steam-electric generating plant at Niles, where tract of about 90 acres of land has been secured, with frontage on Mahoning River. It will be equipped for an initial capacity of 106,000-kw, comprising a single turbine-generator unit of that rating, with provision for second such generator at later date. Cost reported approximately $20,000,000, including switching station, power substations, transmission lines and other operating facilities.

Tulsa, Okla.—U. S. Army Corps of Engineers, Office of District Engineer, 2000 North Memorial Dr., Tulsa, plans call for bids in December for construction of power plant and auxiliaries at Tenkiller Ferry reservoir, Sequoyah County, Okla. Project is estimated to cost over $4,000,000.

Portland, Ore.—Pacific Power & Light Co., Public Service Bldg., is arranging a fund of about $3,500,000 for expansion and improvements in plants and system during 1952, including increased generating facilities, power substations, transmission lines and other work.

Sunbury, Pa.—Pennsylvania Power & Light Co., Hamilton and 9th Sts., Allentown, Pa., has authorized plans for expansion in steam-electric power plant at Sunbury, where extensions are now under way, to be completed early in 1951. At that time, work will proceed on addition, to include installation of a 125,000-kw turbine-generator and accessories, with extension in switchyard and other facilities. Completion is scheduled early in 1953. No estimate of cost announced—will represent large investment.

Fort Worth, Texas—International Minerals & Chemical Corp., 20 North Wacker Dr., Chicago, Ill., plans boiler house at proposed new plant at Fort Worth, for production of chemical fertilizers. It will comprise a main one-story building for processing and general manufacture, and several auxiliary structures. Cost reported about $500,000. Site is being acquired and work is scheduled to begin soon.

Houston, Texas—Ethyl Corp., North Baton Rouge, La., chemical compounds for high octane gasoline manufacture, plans boiler plant at new plant near Houston, where site is being acquired. It will comprise several large processing and production buildings. No official estimate of cost announced—reported over $2,500,000. Work will begin at early date and is scheduled for completion by close of 1951.

Lubbock, Texas—Lubbock Electric Dept. plans expansion and improvements in municipal steam-electric generating station, with installation of new turbine-generator, about 11,500-kw rating, and auxiliary equipment. Cost reported about $1,850,000. A bond issue will be arranged in that amount to provide for project.

Salt Lake City, Utah—Utah Power & Light Co., Kearns Bldg., plans expansion in new steam-electric generating station, now in course of construction on Jordan River near city, which is scheduled for completion in about 10 months. New unit will be equipped with a 75,000-kw turbine-generator, high-pressure boiler and accessory equipment; a 250-ft reinforced-concrete stack will be built. Work will be placed in progress in near future, and is expected to be completed in fall of 1952. Cost approximately $10,000,000.

Charlottesville, Va.—Board of Trustees, University of Virginia, plans new power house at institution for central-heating service. Cost reported over $300,000. Work will be placed under way at early date. Wiley & Wilson, Peoples Bank Bldg., Lynchburg, Va., are consulting engineers.

Charleston, W. Va.—Appalachian Electric Power Co., 129 Campbell Ave., Roanoke, Va., has authorized plans for new steam-electric generating station in vicinity of Charleston, on tract of land on Kanawha River. Installation will comprise a 175,000-kw turbine-generator, high-pressure boilers and auxiliary equipment, with a second generator of similar rating to be installed closely following completion of initial plant, scheduled before close of 1952. Other units will be provided in future, to develop an ultimate capacity of 1,050-kw. Plant will represent a large investment—no official estimate of cost announced.

Milwaukee, Wis.—Rexford Paper Co., 1715 West Canal St., gummed, waterproof and other processed papers, plans boiler house at proposed new plant on local site on West Mill Road. It will comprise a main one-story building for processing and general production, about 85,000 sq ft floor space. Cost reported about $400,000. Work is scheduled to begin early in 1951. Lawrence Peterson & Associates, 312 East Wisconsin Ave., Milwaukee, are engineers.

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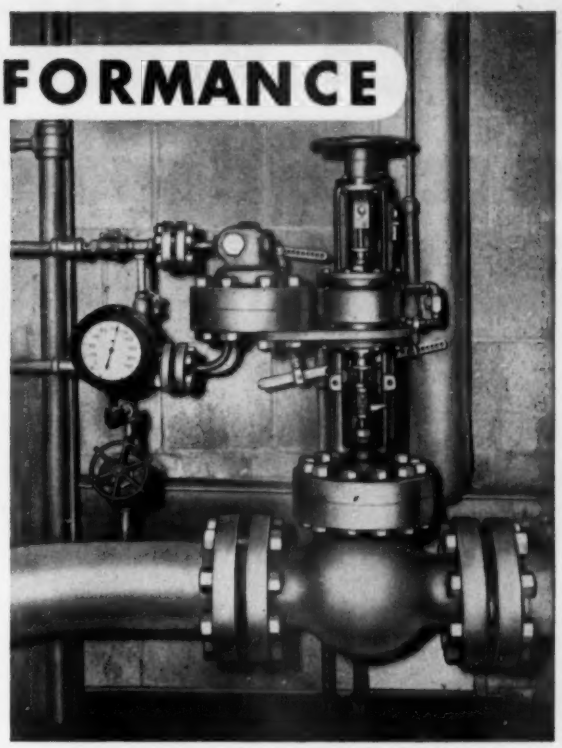

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LETTERS TO THE EDITORS

MR. PAULL REGRETS

I DO NOT REMEMBER when I first subscribed to your magazine. I do remember that many times it has given me pleasure. I also remember that many times it has come at the opportune time with needed information and I remember that at times it has honored me by publishing some of my scribbling.

All this leads up to the fact that (as good friends often do) we must part. Last year, because I reached my 65th birthday, the company retired me. So, now I have nothing to do and no time to do nothing.

Being out of the power house and not expecting to return to it, I have closed that chapter of my life. That entails (among other things) the stopping of my subscription to POWER ENGINEERING.

My regret in doing this is tempered by the thought of the times it has brightened my rather drab way of life.

I close with the wish that you will continue for many years to bring pleasure and knowledge to those who will spend their lives, as I have done, in the interesting and rewarding field of power engineering.

Montebello, Calif. WM T. PAULL

MOTOR IDENTIFICATION — A REPLY FROM BELGIUM

THIS IS a tentative reply to the question asked by S. R. Shortridge in POWER ENGINEERING, July, 1950, page 53, about motor identification.

Some time ago we were faced with exactly the same problem when erecting a new 100,000 kw steam power station consisting of two 50,000 kw turbo-generators, and four 130 T/h boilers; ultimate capacity of the plant to be 300,000 kw. However, starting from scratch gave us a decided advantage as we were unhampered by long established routines.

A good motor index file must serve a twofold purpose:

1. Each motor must be quickly and easily identified.
2. Item for the location of each motor.

We decided to keep two separate filing systems, one for each purpose.

Regarding the filing code we felt it should conform as far as possible to the following principles:

1. To be simple, easy to understand and easy to manipulate.
2. To be precise and clear.
3. To be rational.
4. To be extensible indefinitely.
5. To be as universal as possible (within the plant, of course).

First step evidently was to give each motor an inventory number. This was done very simply by naming the first motor to enter the plant "Number 1," the next one "Number 2," and so on indefinitely (by now we have reached Number 477). That number is engraved in the motor frame, in figures 2 in. high and about ⅛ in. deep; the grooves are then filled with a bright red paint. It is only on very small motors that the over-all dimensions of the figures are reduced. The only way of getting rid of that number would be to chisel it out of the frame.

I think this should meet S. R. Shortridge's requirements Numbers 1, 3, 4 and 5. Regarding requirement Number 2, well, there are always some locations which are hard to get at and to look at; example: street-car motors. All I can say is that our bright red numbers show up from a long way back.

That inventory number is the basis of the first of our two filing systems: identifying the motor.

The identifying index-card is of international standard size to fit into a Kardex visible card system. Here enclosed is a model of the card we use (Fig. 1). Sides 1A and 1B give the usual information, more or less adapted to everyone's special conditions. Side 1C indicates where the motor is located, when taken away, and the reasons why. I think the French words need little translation. On side 1A we also put down the identifying numbers of all the motors that can serve as reserve for this particular one. In the Kardex, sides 1A and 1C always face one another.

In this respect the visible card system is particularly interesting in that, by the use of colored tabs, each card can be made to give a lot of additional useful information. For instance, in our case:

—a red tab placed over the space labeled "S," right lower corner of the card, means that the motor is actually in service somewhere.

—a green one placed over space "M," stands for a motor that is available in the storeroom.

—a black one over space "R" indicates a motor under repair, and thus not available.

An additional sliding colored signal indicates whether a motor is being repaired in the plant's own shop, or outside, and at what time it is due to come back. Thus in a matter of seconds we can see where, let us say, motor No. 350 is located; that motors No. 230-351-352 can be used on the same equipment, whether they are of the same make or not; whether any of the motors No. 230, 351 or 351 is available in the stores,

(Continued on page 90)

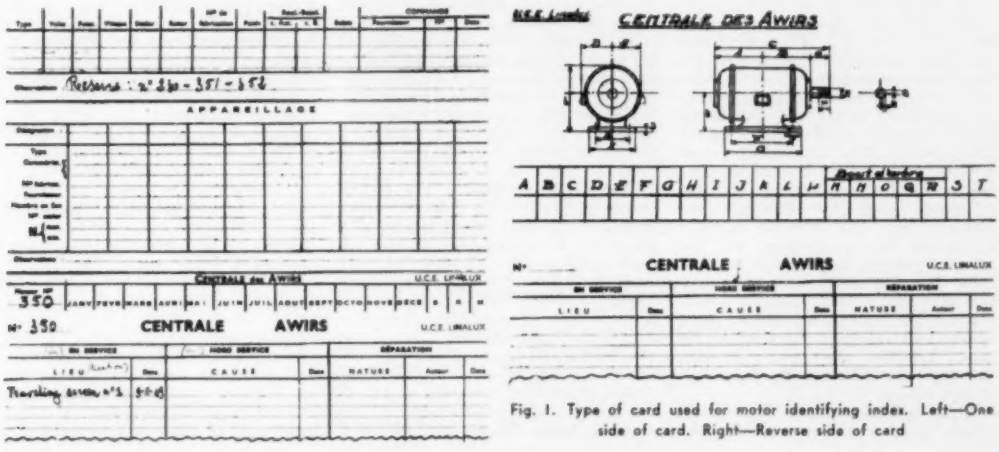


Fig. 1. Type of card used for motor identifying index. Left—One side of card. Right—Reverse side of card

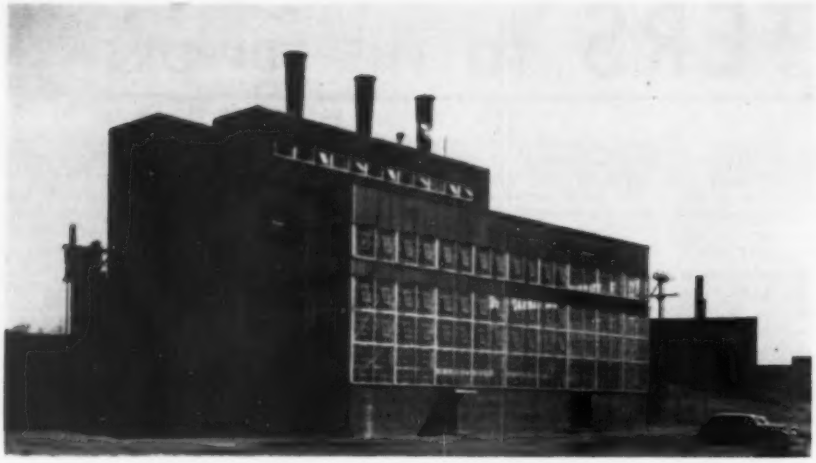


Fig. 1. External view of power plant for Michigan State Reformatory, Ionia, foundation wall. Turbine room walls almost completely of windows and insulated siding above brick foundation wall. Turbine room walls and venturi stacks emphasize modern style of this plant.

Ionia's New Power Plant Typifies Michigan's Institutional Modernization

Based on principle that small power plants need good engineering and that good engineering will produce reliable, low-cost and efficient power plants, State of Michigan carries on progressive power plant construction program in various state institutions . . . Power plant for Michigan State Reformatory at Ionia, Michigan, described here, is typical of the program now being carried out . . . Demand for laundry, kitchen and process steam throughout the year and other allied power plant services makes it economical to operate turbine generator to supply steam and power to this institution . . . Plant of simple yet adequate design at Ionia contains three spreader-stoker-fired, water-tube boilers and one turbine generator unit, with utility standby connections . . . Plant of modern appearance outside and inside; uses well-tested steam and power generating equipment

SMALL PLANTS need good engineering too, said E. R. Little, consulting engineer, in an article under that title in the January 1943 issue of *Power Plant Engineering* (now POWER ENGINEERING). He showed in that article a typical example of how small plants could get good engineering, describing the details of a new power plant recently completed to serve the Newberry State Hospital at Newberry, Mich. That power plant consisted of two stoker-fired, 600-hp boilers supplying steam for heating the hospital buildings and for driving one 500-kw and one 300-kw turbine generator for generating all the electric power used by the institution. The plant was built with very limited funds but, despite that, some very interesting details were worked out to keep the cost of the plant low and the operating efficiency high. These were described in the article.

This understanding that small plants need good engineering, and that they can have it, has motivated the Department of Administration of the State of Michigan in carrying out for the past 3 or 4 years a very interesting and extensive program of modernization and rehabilitation in the power plants of a number of its state institutions, such as hospitals, sanitariums and reformatories. This program has been progressing under the supervision of the Department of Administration, State of Michigan, of which A. N. Langius is director and John E. Miller is chief of the Services Section. The entire program, in addition to power plant construction and modernization, also embraces a considerable amount of new construction of hospital and other facilities, and expansion of existing facilities that cannot be described here. A number of the leading consulting engineers of the State of Michigan have designed the power plants included in this program, which are in various stages of operation and construction at the present time. These will be discussed briefly at the end of this article.

Typical of the sort of engineering involved in these small plants is the power plant completed and placed in operation in January 1949 to serve the Michigan State Reformatory at Ionia, Mich. Another power plant almost identical in design and differing only in a few details of the generating equipment, has also been completed to serve a new hospital to be erected at Northville, Mich.

All the power plants involved in this program are relatively small, ranging from total boiler outputs of around 80,000 lb of steam per hr to 120,000 lb per hr, and generating capacities from about 750 kw to 2500 kw. However, as all power engineers know, in institutional plants of this type all the power service problems must be met with the highest reliability and economy; and there are several services, such as laundry and kitchen services, and often special medical apparatus, not found in most industrial plants.

As the title of this article indicates, the new power plant for the reformatory at Ionia is a very typical example of the engineering employed in carrying out the above program. The plant, as shown in the accompanying illustrations, contains three boilers to serve a maximum steam load of approximately 80,000 lb of steam per hr, together with a 750-kw non-condensing turbine generator for generating power for the institution, with a 100-percent standby for electricity from the lines of the local utility company.

Features of the Ionia Power Plant

One of the features of the plant is its modern appearance, both outside and inside, and its design to provide adequate working space and convenient arrangement of all equipment for ease of operation. All major equipment is on a single operating floor level, as shown in Fig. 3. The walls of the turbine room section are almost entirely glass as shown in Fig. 1, and the office of the operating engineers of the plant is a glassed enclosure on the turbine room floor, shown in the background of Fig. 2.

Beyond the switchboard of Fig. 2 and the engineer's office, all the feedwater treating equipment and pumping equipment is installed at ground level, so that the engineers on the operating floor can look down and observe it and obtain access to it by merely going down a short flight of stairs.

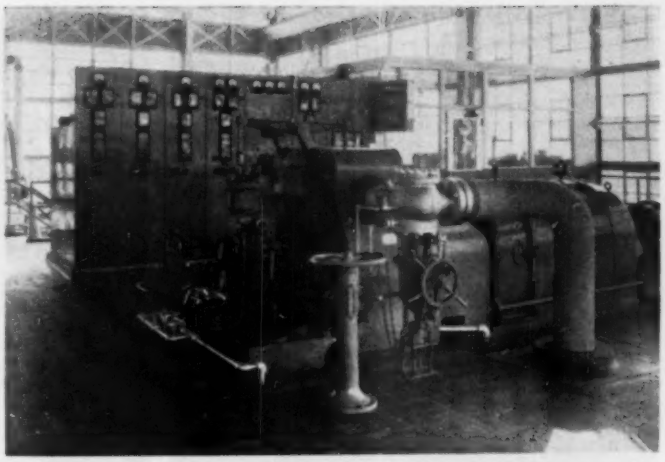


Fig. 2. View of the 750-kw non-condensing turbine generator unit installed in Ionia plant, with electrical control panel in background, glass enclosed operator's office in right rear and, at extreme rear, bay containing all water treatment and pumping equipment

Still another feature of the construction is that the entire operating floor, and especially the turbine room floor and foundations, are completely isolated from the building walls to prevent transmission of vibration. This construction is shown at the extreme right of the operating floor in Fig. 3.

There is ample room in the turbine section for installation of one or more additional turbine generators if they should ever be required. Much care has been exercised in the layout of the water treating equipment, boiler feed pumps and all steam and water piping, so that it will be fully accessible for maintenance or operation of valves and the like. Walkways and catwalks are provided wherever

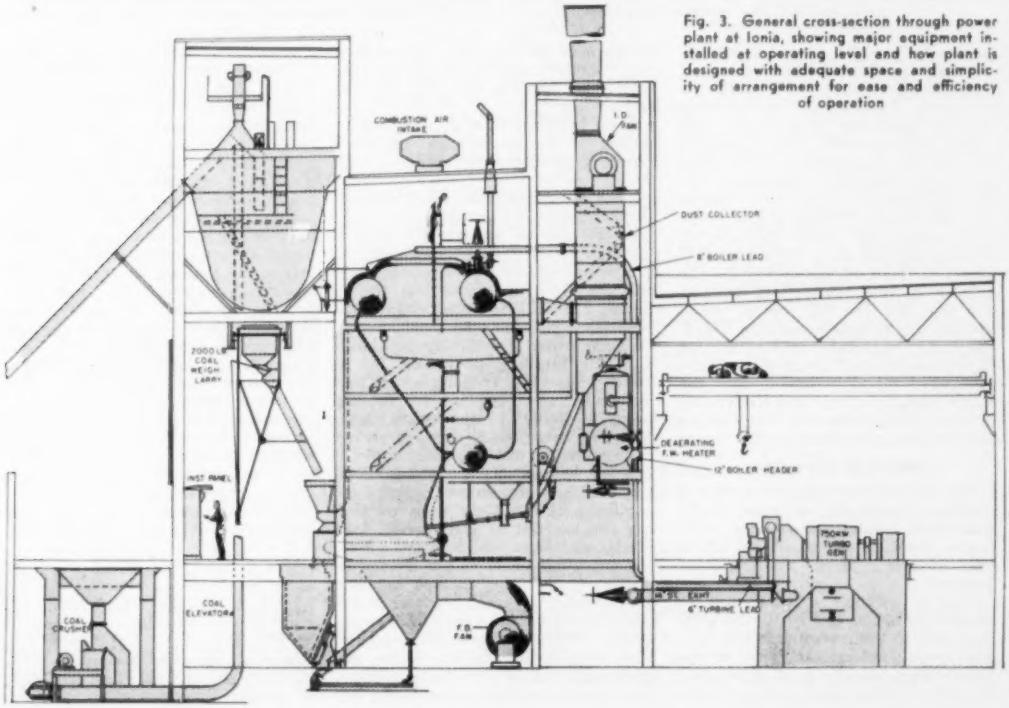


Fig. 3. General cross-section through power plant at Ionia, showing major equipment installed at operating level and how plant is designed with adequate space and simplicity of arrangement for ease and efficiency of operation

Fig. 4. View on firing aisle at Ionia plant showing three 40,000-lb-per-hr, 200-psig, 388 F steam generating units fired by continuous-ash-discharge spreader stokers

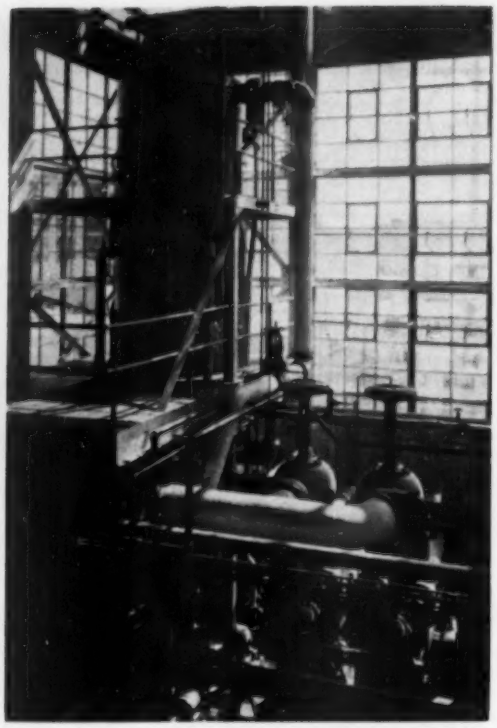


Fig. 5. View of portion of the water conditioning bay, which is easily accessible from the operating level behind the turbine, showing the splendid daylight illumination from turbine room windows

necessary to give access to equipment for operation and maintenance.

In the new Ionia power plant, all necessary controls and instruments are provided for convenience and safety of operation and minimum attendance of operators. The boilers are under complete automatic combustion control; and this control and the required draft gages, pressure gages and other instruments are centralized on a boiler control panel in front of the boilers on the operating floor. Electrical controls are grouped on the control panel behind the turbine generator, Fig. 2. Necessary automatic devices such as boiler water level controls, pressure reducing valves, controls for the boiler feed pumps and feedwater treating equipment are installed on the equipment as indicated.

Details of Boiler Plant

The Ionia power plant contains 3 vertical, bent-tube, 3-drum, high-head-type water-tube boilers, with water wall furnaces. Each boiler and furnace contains 5600 sq ft of heating surface. Each boiler is designed to produce a maximum of 40,0000 lb steam per hr at 200 psig, and 388 F total temperature. The maximum load on the plant is approximately 80,000 lb of steam per hr. The boilers are equipped with steam soot blowers and the necessary water columns, safety valves and other standard accessories as shown in Fig. 3.

Each boiler is fired by a spreader stoker of the continuous ash discharge type, as shown in Figs. 3 and 4.

Coal for these stokers is received in railroad cars, unloaded at a track hopper and if necessary, passed through a coal crusher to a continuous-flow conveyor, which elevates the coal to the top of the boiler house, Fig. 3. From this continuous flow conveyor, the coal may be discharged either to a storage pile outside the building or to the horizontal conveyor running over the suspended steel bunker, which extends the length of the boiler room over the firing aisle. Coal is withdrawn from this bunker into a 2000-lb weigh larry, which distributes it to the stoker hoppers as required, at the same time weighing the amount of coal used. Ash discharged from the forward-moving traveling grate of the spreader stoker drops into an ash hopper, from which it is discharged to a pneumatic type ash handling system, which delivers it to a tile ash silo just outside the boiler house, as shown at the left in Fig. 1. From this silo it is removed by trucks for further disposal at required intervals.

Cinders from the last pass of the boiler, and fly ash from the dust collector hopper, are reinjected into each furnace by an injection system shown in Fig. 3. This is a blower-type system for which the air is supplied by a separate blower for each boiler, mounted as shown.

Combustion air for each stoker is supplied by a 16,860 cfm 4½ in. H_2O, motor-driven forced-draft fan installed at ground level below the stoker. A feature here is that combustion air enters the boiler house through a special intake in the roof just above the boilers, and flows down around them to the intake of the forced draft fans below. This was done partly to preheat the combustion air a slight amount and thus to make sure that in extremely cold weather there would be no possibility of enough cold air getting in to freeze up anything.*

Combustion gases from the furnace pass out through a dust col-

* Such freezing-up occurred in an old plant at the Newberry State Hospital, where the winters are extremely long and cold. In the old plant, air at below zero temperature, combined with snow and drippings from wet coal in stoker hoppers, actually froze up the stoker mechanism. To prevent this in the new plant, combustion air was taken in through a roof penthouse and through an annular space around the main boiler breeching where it was heated about 70 F.

lector to remove fly ash, and from this the gases are drawn by a 27,150 cfm 3.40 in. H_2O motor-driven induced-draft fan, which discharges them through the stack.

An interesting detail here is that the entire dust collector, induced-draft fan and venturi stack assembly were designed and installed as a single unit by the manufacturer. (Note the expansion joint between the breeching and dust collector, Fig. 3.)

Feedwater Handling

Boiler feedwater make-up, which is approximately 20 per cent, comes from deep wells. It is treated by a hot-processs lime-and-soda-ash system, supplemented by internal chemical treatment in the boiler drum. From the water treating system the water is pumped to a 60,000-lb-per-hr deaerating feedwater heater, Fig. 3, from which the boiler feed pumps take suction and deliver the feedwater direct to the boilers.

The boiler feed pumps are 200 gpm 300 psi discharge pressure, steam-driven reciprocating pumps.

These pumps, together with all the feedwater treating equipment, are installed at ground level in a bay at one end of the turbine room, that is, in the background of Fig 2. Here, also, are installed heaters and softeners for domestic water for the reformatory, together with the necessary water service pumps, return condensate system, and the like. Thus all equipment handling water for both boiler feed and for service to the reformatory is grouped together for convenience of operation and maintenance.

Turbine Generator

In the turbine room is installed a 750-kw non-condensing turbine generator Figs 2 and 3. The turbine is designed for throttle pressure of 200 psi, 388 F, and exhausts at 5 psig to a 14-in. steam header leading to the reformatory where it supplies steam for building heating, laundry, cooking and other institutional uses.

The turbine drives a 950 kva, 0.8-pf, 4800-v, 3-phase, 60-cycle generator, which has a direct-connected exciter and a generator air cooler as shown in Fig. 3.

To supplement the electric power supply from the turbine generator and also to insure service in event of an inside power failure, a tie-in connection is made with the transmission lines of the Consumers Power Co. through a substation of that company located just outside the power plant.

Operating Data

The plant at Ionia has been operating now for well over a year, the boilers having been placed in operation in September 1948 and the turbine generator in January 1949. Some of the results of operation are given below.

Average coal consumption in the old plant for the previous years was approximately 15,000 tons per year. Coal consumption for the past twelve-month season, from a brief summary of operating reports, is approximately 12,000 tons, indicating that with the same facilities operating, and with a slightly milder winter season, the new plant is resulting in a considerable saving in operating costs from a fuel standpoint.

Similar Plant at Northville

As noted above, a plant very similar to this has been built to serve the Northville State Hospital now being constructed at Northville, Michigan. This plant will also contain 3 boilers, each of which has 6700 sq ft of heating surface, including the furnace water walls, and each is capable of a maximum output of 50,000 lb of steam per hr at 200 psi and 100 F superheat or 487.9 total temperature. These boilers are also of the vertical, bent-tube, 3-drum type, and are steel encased like those at Ionia. They are fired with continuous-ash-discharge type spreader stokers and are equipped with forced and induced draft fans, venturi type stacks, and dust collectors. Boiler feedwater will be softened with a hot-process lime-and-soda-ash system, and since the water is supplied from deep wells, it will be deionized before it is softened. Domestic water is treated with zeolite.

In the Northville plant, space is provided for the installation of a 1500-kw and a 1000-kw turbine generator to generate 3-phase, 60-cycle, 4800-v power. A standby connection will also be made to the public utility's transmission line. Steam for heating will be distributed in this plant at 50 psi, taken by extraction from turbine, while a 100-psi lines runs to the hospital for kitchen and laundry work. The turbines will exhaust at 5 psig for feedwater heating and other heating services in the hospital.

Both these plants were designed by the E. R. Little Co., engineers, of Detroit, in co-operation with O'Dell, Hewlett and Luckenbach, consulting architects of Detroit.

As stated above, they are typical of the sort of work included in this expansion and replacement program at various Michigan state institutions.

Other Power Plants in Program

Other power plant work included in this program, either completed or under construction, includes the following: Ionia State Hospital power house, Ionia, Mich., consulting engineers—H. E. Beyster Corp.; Michigan State Sanitarium, Howell, Mich., and Traverse City State Hospital, consulting engineers—Allied Engineers, Inc., Detroit; The Kalamazoo State Hospital, consulting engineers, Fargo Engineering Co., Jackson, Mich.; Northern Michigan College of Education, Marquette, Mich., consulting engineers, Cummins and Barnard; Michigan College of Mining and Technology, Houghton, Mich., consulting engineers, Snyder & McLean.

Proposed new plant for the Michigan School for Deaf, Flint, Michigan:—planning documents now being prepared by E. R. Little Co., Inc., consulting engineers, and O'Dell, Hewlett & Luckenbach, architects. Major improvements to power plant at Lapeer State Home & Training School, Lapeer, Michigan:—reconditioning of 4 boilers, installing water walls on two existing boilers, induced draft fan system on 4 boilers and installing ash removal system for all boilers; E. R. Little Co., Inc., consulting engineers.

Further details of the over-all power plant program of the State of Michigan, also details of some of the other plants just listed, will be given in a subsequent article.

Principal Equipment, Power Plant, Michigan State Reformatory, Ionia, Michigan

Boilers	Wickes Boiler Co.	Combustion Control	Hays Corp.
Turbine Generator	Westinghouse Electric Corp.	Coal Handling Equipment	Stephens-Adamson Mfg. Co.
Stokers—Roto-Stokers, Continuous Ash Discharge	Detroit Stoker Co.	Ash Handling Equipment	United Conveyor Corp.
Forced-Draft Fans	American Blower Co.	Electric Crane	Shaw-Box (Div. Manning, Maxwell & Moore, Inc.)
Induced Draft Fans, Stacks, (Venturi) Dust Collectors	(Thermix) Prat-Daniel Corp.	Electric Switchgear	General Electric Co.
		Vacuum Cleaner	The Spencer Turbine Co.
Boiler Feed Pumps	American-Marsh Pumps, Inc.	Domestic Water Heaters	Patterson-Kelley Co., Inc.
Boiler Feedwater Softeners—Hot Process	Cochrane Corp.	Domestic Water Softeners	Graver Water Conditioning Co.
		Soot Blowers	Diamond Power Specialty Corp.
Boiler Feed Deaerating Heater	Cochrane Corp.	Chemical Feed Pumps	Cochrane Corp.
Boiler Feedwater Regulators	(Copes) Northern Equipment Co.	Condensate Return Pumps	American-Marsh Pumps, Inc.

Power From Steam Wells

Success of Italy's utilization of power from steam wells in the volcanic region around Larderello in Tuscany has created interest in tapping similar sources of thermal energy in other parts of the world. New Zealand is considering the possibilities. In Italy, the present wells, which have been in operation for a number of years, are being extended. Some of the new wells as deep as 1000 ft

THERE ARE A FEW places in the world where nature has provided steam plants, built practically to order. These are the volcanic regions where steam issues from fissures in the ground. The most famous of these regions is the Larderello district in Tuscany, Italy. These steam wells have been known for many years and have been an important source of power. Recently, the increased demands for power have started a new program of development which will boost Italy's present electric power output by approximately 10 per cent.

The Larderello area has produced nearly 300 live steam wells which have been tapped to produce a volume of nearly 1,200,000 kwhr of electrical energy daily.

The steam wells are sometimes 1000 ft deep and require nearly a year to drill. Just before the drillers strike steam, the entire crew dashes for safety, as the explosion of the steam well wrecks all operating equipment and the blast is heard nearly twelve miles away. The steam wells are allowed to "clean" themselves out for about two weeks, then are capped and controlled. The steam is drawn off by a complex series of pipelines to condensation tanks and eventually converted into electricity. The recent completion of the eighth in a series of huge turbine plants makes possible a production of approximately 32,800,000 kwhr of electricity a month. Almost all the industrial, railroad, and domestic consumption of electricity in northern Italy is met by the production of power from this natural source.

Although the source of power has been known of for nearly a hundred years, it has only been in the last few years that engineers have succeeded in capitalizing on the supply. Lacking coal resources and oil reserves, Italy has had to depend on its other natural resources to provide electricity for its expanding industrial program.

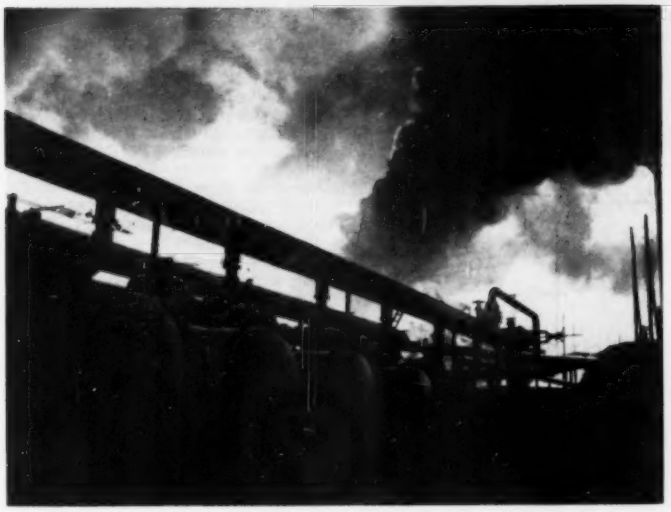
It is the only place in the world where man has controlled and harnessed the gargantuan strength of underground volcanoes. Steam power for electricity is not the only output of this "Valley of Hell" as it called. More than 8,000,000 tons of chemical products, pure borax, carbonic acid, ammonia, boric acid, etc., are produced as by-products and nearly half of this volume is exported.

The extension of these facilities at Larderello now under way rank near the top of Italy's post war power expansion program, designed to meet an annual deficiency of some 13 billion kwhr. Larderello's new stations will have an installed

Fig. 1. Life goes on as usual on top of the world's most powerful volcanic area. A farmer and his team of oxen pass through the region of natural steam wells at Larderello in the Tuscany area of Northern Italy

Fig. 2. (Right) A general view of the scene of operations at Larderello showing two of the large cooling towers at the left and a third tower at the right nearing completion

Fig. 3. (Below) A closeup of the scene of operations with three wells spouting live steam



capacity of 250,000 kw. A new system will be used in the plans now under construction for utilizing the steam from new drillings. The steam will be sent directly into a turbine with low pressure discharge to a mixing condenser which was recently fitted with a turbo-vacuum for extracting the gases. The turbo-vacuum apparatus had to be made of special steel resistant to corrosion by the gases contained in the steam.

The success of the Larderello wells has resulted in interest in this form of power development in other parts of the world where underground steam supplies are know to exist. One of these is in New Zealand. In accordance with a report issued by the Director of the New Zealand Geological Survey, if the Italians have been successful, their scheme can be duplicated in New Zealand. Indeed, it is estimated that enough power could be developed from the thermal steam to equal all the hydroelectric stations on the Waikato River, where work in progressing on New Zealand's greatest power project.

It seems that the Italian and the New Zealand thermal areas are very similar. The New Zealand area involves a belt of volcanic ground stretching from White Island in the Bay of Plenty, to Taupo. Scientists, however, still have to determine whether the earth's structure is suitable for the collection of steam under pressure.

The origin of New Zealand's thermal steam is thought to be very deep whereas the Italian supplies come from about 600 ft down on the average. The Italians, however, are planning to put down some very deep bores, and the results of these drillings will be of great interest and value to New Zealand.

Fig. 4 (Left) Hot water tanks at Larderello where live steam from the earth heats water to 220 F

Temperature Limits

For Steam Generator Design and Operation

In both the design and the operation of modern steam generators it is essential that the temperature of various materials used in construction of the boiler and furnaces, and also the fuel and air involved in the combustion process be maintained below certain maximum temperatures. In this article, Professor Anderson discusses these temperature limits from the standpoint of both the designer and the operator of today's steam plant equipment

By CLIFFORD O. ANDERSON,
Associate Professor, Mechanical Engineering, North Dakota Agricultural College

IN THE DESIGN or operation of the modern steam generator, an understanding of the inherent characteristics of the working medium and the materials of construction is useful in describing the limits imposed on the generator. These limits may be defined by the temperatures encountered, especially for the combustion air, the combustion gases, the fuel, and the steam. The materials of construction may also be limited by service temperatures due to the fact that their mechanical strength is reduced markedly at high temperatures. Metals in particular, if they are not cooled by air or water, will lose their utility at the temperature of superheated steam and the refractories cannot resist the highest attainable temperatures of the combustion gases. Fuels ignite at temperatures below the value of the hottest stack gas outlet temperature. Pressures may also be a limiting factor, but economy usually dictates these values. Temperature, then, appears to be more conveniently useful as the limiting factor than pressures for the multitude of factors which must be considered in operation and design.

To point out the limits on temperature, it seems best to take each factor separately and indicate the limits with the reasons why these limits are fixed by some characteristics of the material or medium. Of course, these factors do influence one another but separate consideration will make their limits more readily understood.

Fluid Cycle Requirements

In prescribing the limits of operation for a steam generator it might be well to inspect the fluid cycle from the ideal viewpoint. We can then define the function of the steam generator by its position in the fluid cycle. We may also see how the steam generator function is limited by the turbine throttle condition on the high side and the condenser on the low side, with reference to temperature and pressure.

To illustrate, in Fig. 1, on the temperature-entropy plane for water vapor, the points A, B, C, and D are significant as terminals for the four processes carried out by the major steam plant equipment. In Fig 2, a diagram of the fluid flow through the equipment, these points may be correlated with the same symbols in Fig 1. These processes and the associated equipment can be outlined briefly as follows:

A to B or E to B	The addition of heat to the fluid in the steam generator. (Fig 3)
B to C	The expansion of steam in the steam turbine.
C to D	The removal of heat in the condenser.
D to A	The increase in pressure by the feedwater pump.

Where feedwater heaters are used, and this is the usual practice, the heaters assume a part of the heating of the feedwater and the cycle must be modified, as in Figs 3 and 4, to illustrate this operation. An additional process must then be considered, that of A to E for the heater. The steam generator will then operate from some point such as E, which will be above the original point A as shown in Fig 3.

In addition, we ought also to recognize some of the physical properties of water as a working medium. Ideally, water has a freezing point of 32 F and a vapor pressure of 0.08854 psia and a critical point at 705 F and 3206 psia. Practically, the limits are closer to 40 F on the low side and under 705 F for water vapor in the saturated state on the high side. For superheated steam the maximum temperature is usually taken as 1000 F, although higher useful temperatures are in the offing with recent developments.

With these principles in mind we can proceed to the other considerations which limit operation or design of the steam generator.

Material Limits

The cycle requirements for steam generation show principally the characteristics of the water vapor working medium, but nothing about the materials of which the equip-

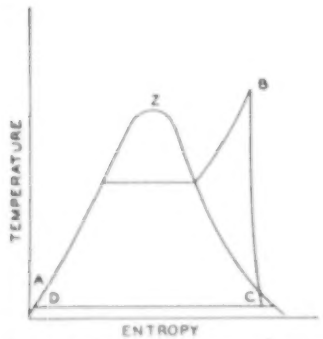


Fig. 1. Temperature entropy diagram for water vapor

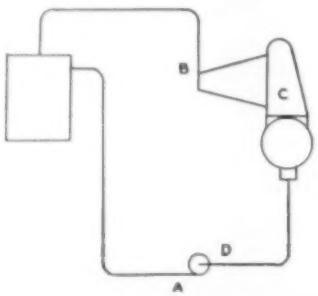


Fig. 2. Diagram of the fluid flow through the equipment, corresponding to entropy diagram in Fig. 1

ment is constructed. These materials, mainly steel and refractory substances, are limited by their inability to retain their mechanical strength at high temperatures.

Therefore, working temperature must be limited or the materials must be cooled by water or air. If we consider the furnace enclosure as a box lined with refractory and supported by steel members, into which the generating surfaces have been inserted for the purpose of absorbing the heat of combustion, we have a basic concept of the modern steam generator. To prevent the collapse of the refractory walls subjected to high radiant heat, vertical tubes, as part of the boiler circulatory system, are placed to shield the walls and absorb most of the radiant energy. The boiler tubes being filled with water, which is circulating, are subjected to the high temperature combustion gases on the outer surface only. Metallurgists tell us that the limit for ferrous metals is about 1000 F, but the tubes in the furnace being cooled by water do not reach this high value. The refractory brick will fail at 2500 F unless some cooling such as given by the water is installed. Therefore, we ought to keep in mind these two temperatures for the interior surfaces of the furnace and limit our operation to fall below these limiting values. The point of how these high temperature values are attained will lead us to the consideration of the possibilities for heat release by the chemical process known as combustion. This chemical reaction takes place through the ignition of the fuel in the presence of sufficient air. It might be well to consider the fuel and air separately, because the preheating of the air influences the ignition of the fuel and its temperature should be limited to prevent harmful effects.

Fuel Properties

The fuel burned may limit the operation of the steam generator because of its composition. Consider a solid fuel whose composition may be broken down into fixed carbon, volatile matter, moisture and ash. The ignition temperature of a solid fuel is approximately 800 F or lower and by the standard tests, the volatile matter is completely distilled off at 1750 F, leaving coke and ash as a residue. With an air blast, coke will provide a temperature of 3000 F which is high enough to melt a low carbon steel as in the metallurgical furnace. Clearly this action is to be avoided in the steam generator furnace. The fusion temperature of the ash may occur at a point below 2500 F so that this temperature is considered the limiting condition for attainable temperature in the furnace if slagging of metal and refractory surfaces is to be reduced or prevented. In using primary air for pulverized fuel transport,

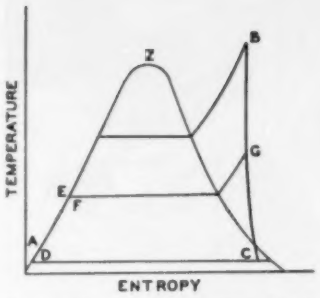


Fig. 3. Entropy diagram, similar to that in Fig. 1 but involving a feed-water heater

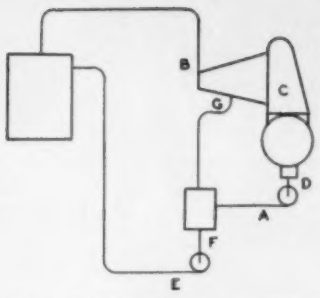


Fig. 4. Fluid flow diagram corresponding to Fig. 3

the temperature of that air must be held to a point lower than the ignition or distillation point of the fuel. This value may need be as low as 250 F or reach 600 F depending upon the composition of the fuel. The sulphur content of the fuel will also limit the operation, for if the oxide formed combines with the water vapor a corrosive condition may result from condensation of the acid vapor when the temperature falls below 250 F. Other fuels, gaseous or liquid, may have limiting values but the previous statements will serve to illustrate the point without further explanation.

Stack Gases

The product of the reaction between the fuel and air is a mixture of gases including water vapor. These stack gases carry the thermal energy to the generating surfaces by means of which the heat is absorbed and transferred to the water, or superheated steam. Its temperature may be regulated somewhat by the amount of excess air supplied, but must be high enough to affect a transfer of heat without incurring unusual losses. Generating surfaces are placed to take the best advantage of the hot gases or radiant heat from the incandescent fuel. The temperature of the gases at the boiler outlet must be greater than the saturation temperature of the water to give a transfer of heat to the water in the downcoming tubes in the last pass. This may mean a temperature differential of 300 F. For a steam generator operating at 415 psia the saturation temperature is 445 F which might require an exit gas temperature of 7500 F or less. The superheating of the steam is not affected by this temperature as the superheater elements are installed at the top of the first pass to experience the transfer of heat in the hottest part of the furnace. Obviously, the discharged gases have a high heat content and thus it becomes possible to install heat re-

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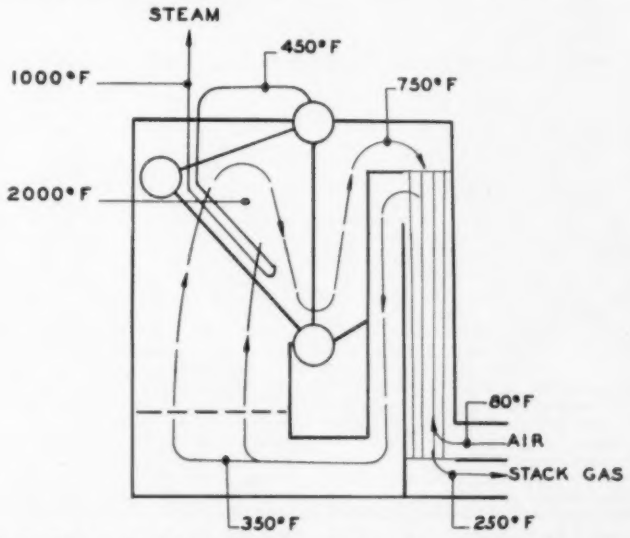


Fig. 5. Diagram of a 3-drum boiler showing the temperature limits for various parts of the system

Fig. 1. How manila rope is made. Correct fiber blending is a skill learned from long experience alone. From the many available varieties and grades must be chosen those which will combine to meet strength, texture, color and other requirements of the finished product

Fungicidal Treatment of Manila Rope

Rope is a very important element in the Underground and Overhead Line Departments of Public Utility systems, and a great deal of it is used. Exposed to the weather, subject to the effects of moisture and fungi it deteriorates rapidly unless steps are taken to preserve it. In this article, the author describes the work done by the Dayton Power and Light Co. in testing the effect of various preservatives applied to manila rope. No conclusions are drawn but the results of the tests should be of definite interest to all users of rope, whether it is used in public utilities or in industrial power plants

By **FRED M. REITER**, Material Research Engineer, The Dayton Power and Light Co.

FOR A NUMBER OF YEARS vendors have tried to interest our company in adopting treated rope as our standard rope. Some treated rope has been bought but it had not been very satisfactory; those who remembered it said it was dark, and that it had irritated the hands. It may have contained creosote. Its higher cost was also a deterring factor.

Since other cellulose fiber materials such as poles, crossarms and timbers are successfully treated against decay, it seemed logical that with proper methods the treatment of rope should be equally advantageous. Our rope is subject to weather and moisture in both our Underground and Overhead Line Departments and after use in wet weather there is always danger of decay if the rope is not dried before storage in trucks or other places. Many firms require wet rope to be laid out to dry as a protection against rot.

We decided, therefore, to study the question of rope treatment. Most of the treated rope on the market used a trade-name preservative the fungicidal constituent of which was not disclosed. It was therefore necessary to know what commercial preservatives were available.

During the war, the U. S. Armed Forces had developed preservatives that were effective in protecting tent fabric and similar material against jungle rot in the South Pacific areas so we consulted the Fungus Control Unit of the Materials Laboratory of the U. S. Air Forces at the Wright Patterson Air Force Base. As a consequence, we obtained samples of preservative materials for fabrics from sources which they suggested.

Arrangements were made with the Research Department of the Hoover and Allison Co. at Xenia, Ohio, one of our rope suppliers, to cooperate in the study by supplying lengths of untreated, and regular cordage oil treated manila rope with spliced-in loops for pull tests after treatments were applied. Three sets of tests were decided upon:

1. Soil burial and resultant strength. Resistance to decay would show up in the breaking strength of the rope after exposure to fungi.

2. Electrical resistance of the treated rope, before and after weathering. Since the rope was used in connection with power line construction, there always exists the hazard of grounding current flow through rope lines. All rope purchased by The Dayton Power and Light Co. for power line use is tested for electrical resistance before being issued to line crews. This is standard practice.

Table I. Visual Indications After Soil Burial

Specimen No. Treatment Code	Unburied	Buried 14 days	Buried 28 days
A	Natural tan.	Gray, brown-black patches of fungi throughout fibers.	Gray, brown-black patches throughout fibers. Musty odor.
B	Natural tan.	Gray, yellow, brown, black spots throughout fibers.	Gray, yellow, brown-black spots throughout fibers. Musty odor.
C	Pale yellow green.	Pale yellow green.	Pale yellow green.
D	Natural tan.	Natural tan.	Natural tan.
E	Pale yellow green.	Pale yellow green.	Pale yellow green.
F	Dark brownish gray.	Dark brownish gray. Spotted throughout with fungi. Musty odor.	Dark brownish gray. Spotted throughout with fungi. Bad musty odor.

3. Decay by weathering or exposure to humid atmosphere, such as might occur in storage under moist conditions.

These tests were run in the laboratories of The Dayton Power and Light Co. and The Hoover and Allison Co. They were not meant to be final, absolute, tests since the number of samples was limited and conclusively authoritative results were not sought. It was merely an initial effort to compare a few treatments before running field trials. We planned to have rope made up in accordance with a treatment determined by the tests, as developed by the rope manufacturer. The test ropes would be tried out in actual field use by our Underground and Overhead Line Departments before acceptance and before setting up standards and specifications.

Code of Rope Designations

The rope used in the tests was manila, ½ in nominal diameter, right (regular) lay. Lengths were 4 ft with 7-in. loops spliced on each end. Normal test gage length was 40 in. Rope specimens were prepared by The Hoover and Allison Co.

Six different treatments were made as follows:

A—Regular productive rope containing its normal 14 percent cordage oils.

B—Dry (untreated) rope containing about 0.25 percent cordage oil.

C—Dry rope "B" to which was added 2 percent copper-8-quinolinolate and 4 percent wax.

D—Regular rope "A" containing 14 percent cordage oils plus an appropriate percentage of fungicide "D".

E—Dry rope "B" without wax but with 2 percent copper-8-quinolinolate.

F—Regular rope "A" containing 14 percent cordage oils plus an appropriate percentage of fungicide "F".

The ropes treated with the usual cordage oils were of a different fiber blend; but they were selected to have mechanical properties comparable to the dry (unoiled) ropes to which the fungicidal treatments were applied.

Twenty four of the 4 ft specimens were leached in 60 F running tap water for 24 hr. The quantity and flow of the leaching bath was such that all water in the bath was replaced at least six times during the 24-hr leaching period.

Half the number of specimens were buried in the infested soil burial bed maintained at approximately 30 C with an atmospheric relative humidity of 92 percent. The remaining specimens were hung on a rack

Table II. Pull Tests: 14 Days Soil Burial

Specimen No. Treatment Code	Lbs. Pull at Break Unburied	14 Days Burial	Loss %	Stretch in 40 in. Unburied Inches	Buried Inches	Loss %
A	2340	1500	36	4.5	3.5	22.2
B	3050	1850	40	6.0	4.75	20.8
C	2910	2660	9	5.5	5.5	0
D	2630	2620	5	5.0	4.5	10.0
E	2570	2330	10	4.75	4.5	5.3
F	2610	2160	18	5.0	4.25	15.0

Table III. Pull Tests: 28 Days Soil Burial

Specimen No. Treatment Code	Lbs. Pull at Break Unburied	28 Days Burial	Loss %	Stretch in 40 in. Unburied Inches	Buried Inches	Loss %
A	2240	1185	48	4.15	3.5	22.2
B	2780	1690	40	9.0	4.5	50.0
C	2400	2700	+12	5.0	5.25	+5
D	2600	2460	6	5.25	5.25	0
E	2250	2240	+8	5.0	5.0	0
F	2130	1780	17	5.0	3.75	25

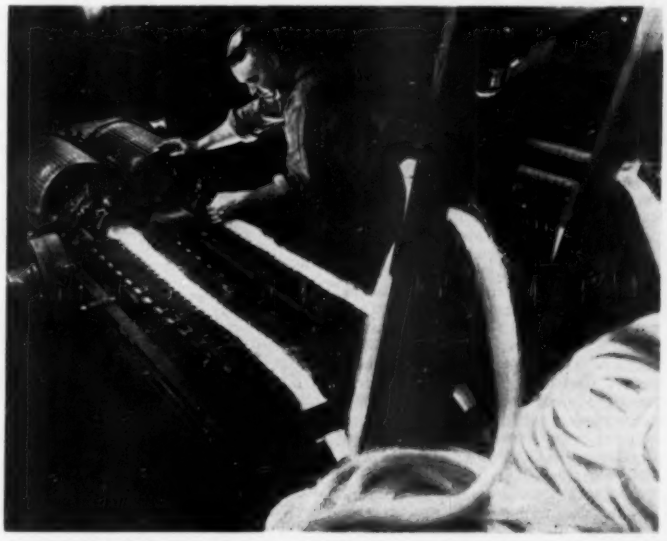


Fig. 2. Twisting the yarns. The amount of twist in a yarn is a vital factor in making a good rope. Too much twist reduces fiber strength, too little twist results in fiber slippage. This machine is designed to provide just the right amount of twist

Table IV. Electrical Resistance Tests
14 Days Burial

Specimen No. Treatment Code	No. of Tests	Unburied Ohms on Megger	Volts for 3 minutes	No. of Tests	Buried Ohms on Ohmmeter	Volts at Failure	Effect of Water Soakings* Ohms on Ohmeter	Volts at Failure
A	2	Infinity	30,000	2	100,000	7,500	340,000	8,250
B	3	"	"	2	75,000	6,500	10,000	3,000
C	2	"	"	2	1 to 8 million	8,250	200,000	8,250
D	5	"	"	4	500,000	11,000	100,000	9,250
E	3	"	"	2	300,000 to 2 million	9,500	15,000	3,750
F	2	"	"	3	28,000	4,000	30 million	25,000
G	A +2% quinolinolate		"	2	350,000	11,250	450,000	9,250
H	Specimen D dried in air for 1½ hr after submerging in water				——		230,000	11,000

*Unburied fresh rope soaked in water 15 min., wiped with towel and air dried 45 minutes.

in the laboratory at room temperatures to serve as control specimens.

At the end of the normal 14 day exposure period in the fungus bearing soil, half the buried specimens were removed from the soil, washed in running tap water at 60 F and air dried in an air conditioned room at 70 F and relative humidity of 65 percent. After thorough drying, these rope specimens were visually examined for changes in appearance. Table I gives the visual characteristics of the rope specimens for both the 14 and 28 days burial.

The effect of rot was then determined by pull break tests on the Amsler Universal testing machine, 40,000 lb capacity, 4,000 lb dial, using a gage length of 40 in. Table II shows the loss in both strength and stretch due to burial and fungus action.

At the end of 28 days burial, a set of specimens was removed and the test procedure repeated. Table No. 1 shows the visual changes in 28 days alongside similar observations of the unburied control and the 14 days exposure specimens. Table III gives the strength and stretch results after 28 days burial similar to those after 14 days burial contained in Table II.

Electric Resistance Tests

The purpose of the electrical resistance tests was to determine the loss of resistance due to rot and moisture. Fungi have the capability of attracting moisture. This might render the rope hazardous to line crews in the field where high voltage exposure might occur.

Electrical tests were run at the Electric Testing Laboratory of The Dayton Power and Light Co. using step-up transformers with induction control. The point of breakdown or failure was indicated by observed flash or burning of the rope specimen. Contact clips were placed across 12 in. test lengths and the transformer voltage applied in slowly increasing increments up to a maximum of 30,000 v where it was held for three minutes. Merely as a guide to expected results or for information just prior to the electric test for each specimen, apparent ohms resistance was measured across 12 in. by means of a megger.

Table IV gives the results of these tests for the unburied and 14 day exposure specimens. All of the unburied specimens showed an infinite resistance reading on the megger and not one failed after 3 minutes exposure to 30,000 v. However, all the buried specimens failed when exposed to generally less 35 percent of the required 30,000 volts, regardless of treatment.

It was believed that this loss in resistance was caused by moisture absorption. To check on this, a set of unburied specimens were submerged in tap water for 15 minutes, wiped with towels to remove adherent surface moisture and dried in air at room temperature for 45 minutes. The last two columns of Table No. 4 show the results of exposure of these wetted specimens to the high voltage current flow. It was thought that this wetting test might serve to check the moisture repellent properties of the various treatments. However, unless a rope was coated as a whole instead of treated in the yarns, it seemed that capillary absorption of water would reduce electrical resistance materially.

Table V. Effect of Exposure to Simulated Jungle Conditions
Humid Atmosphere 85 deg. F. 98% Relative Humidity
UNBURIED SPECIMENS

Specimen No. Treatment Code	Condition After 109 Days Exposure	Relative Rating
A	Tan color. Copious fungi: yellow, black, red, green, orange, gray mildew. Rope swelled in size. Rope limber. Odor.	Very bad
B	Light tan color. Some fungi: black, orange. Rope swollen some. Rope stiff. Musty odor.	Bad
C	Clean, bright pale yellow green color. One faint suspicious spot of yellow fungus. Rope limber. No odor.	Very good
D (1 Sample)	Tan color. Some gray, black, green fungus. Rope stiff, slightly swelled. Slight odor.	Bad
D (2 Samples)	Tan color. No visible fungi. Rope not so stiff. No odor.	Good
E	Excellent, glossy pale yellow green color. Clean. Rope limber. No odor.	Excellent
F (1 Sample)	Dark gray color, larger diameter, fibers swelled. No fungi. Rope limber.	Very good
F (1 Sample)	Dark gray color. Fungi: black, yellow, spores. Rope stiff. Musty odor.	Bad

Table VI. Effect of Exposure to Simulated Jungle Conditions
Humid Atmosphere 85 deg. F. 98% Relative Humidity
SPECIMENS BURIED 28 DAYS

Specimen No. Treatment Code	Conditions after 109 days exposure	Relative Rating
A	Considerable fungi: orange, gray fuzzy mildew, fibers bursted out. Rope stiff. Musty odor.	Bad
B	Badly stained. Fungi: black, gray, orange. Diameter enlarged. Gray mildew fuzz growths. Limber. Odor.	Very bad
C	Glossy pale yellow green color. Excellent condition. No fungi. Rope limber. No odor.	Excellent
D (1 Sample)	Dark tan color, gray fungi on outside surfaces. Rope swelled and stiff. Musty odor.	Bad
D (2 Samples)	Dull dark tan color, black fungi on fiber ends (break off) (leaching). Rope stiff. No odor.	Fair
E (2 Samples)	Good, clean, pale yellow green color, no gloss due to earth adherence. Rope limber. No odor.	Very good
F	Dirty dark gray color. Fungi: green, black, brown. Rope swelled but limber. Odor.	Very bad

Specimens D and H showed the advantage in increased drying out of any rope in improved resistance, such as practiced by firemen who spread their hose in the sun or those linemen who stretch out their wet ropes to dry before reuse.

Electrical tests were not run on the 28 day burial specimens because the results of fungus decay and moisture were obvious.

Exposure to Humid Atmospheres

After the above tests, two sets of specimens, unburied and buried for 28 days, were hung in a warm humid room maintained at 85 F and 98 percent relative humidity. At the end of 109 days they were visually examined for fungi, color, stiffness, size and odor. Table V portrays what developed among the set of unburied samples, while Table VI shows the condition of the different ropes which had various types of treatments and 28 days of burial.

The condition of those ropes was quite interesting in many ways:

1. Accelerated effect of simulated jungle conditions in showing up various colors of fungi, swelling, stiffening, etc.

2. Advantage of fungicidal treatment in general.

3. The differences in preservative effects of various fungicidal chemicals.

While utility company ropes in the U.S. are not exposed to jungle conditions, in underground or outdoor overhead line work, rope gets moist from exposure and rain and will be subject to decay and premature failure. Marine uses of rope are more subject to rotting and have even greater need for preservative treatment than utility rope needs.

This article is written solely for the presentation of the facts obtained from the tests undertaken. No conclusions or recommendations are offered.

The Dayton Power and Light Co. purchased a 600 ft length of one inch Manila "Blueheart" rope that was treated experimentally by the Hoover and Allison Co. with "Cunilate," a particular trade name of copper-8-quinolinolate supplied by the Scientific Oil Compounding Co. of Chicago.

This test rope will be used as a field trial rope by our Underground Rope. It will be some time before we know its capabilities.

We wish to extend our thanks to the Plymouth Cordage Co. of Chicago for the use of the two photographs shown in this article.

Gilbert Station Control Room Has Unusual Louver-All Ceiling

By P. E. KING
Illuminating Engineer, Gilbert Associates, Inc.

AT THE Gilbert Station of New Jersey Power & Light Company a recently-completed louver-all lighting installation in the main station control room incorporates a novel method of installing slimline fluorescent lamps above the louvers. Much has been written about louver-all ceilings but few data are available about placing the lamps above the louvers.

This installation seems to work out satisfactorily and here is how it was made.

A metal wire duct 2½ in. by 3 in. was provided, and lamp sockets were placed on 12-in. centers on the sides of the duct, contrary to usual practice. This permits unusual flexibility; lamps may be easily added by merely adding sockets and wire if higher intensity lighting is required in the future.

The ballast heat problem has been taken care of by placing the ballasts at a remote location. The ballasts are located in the room above the control room and are connected to the lamp raceway by a connecting wireway. The remote location effectively eliminates all noise and heat from the control room.

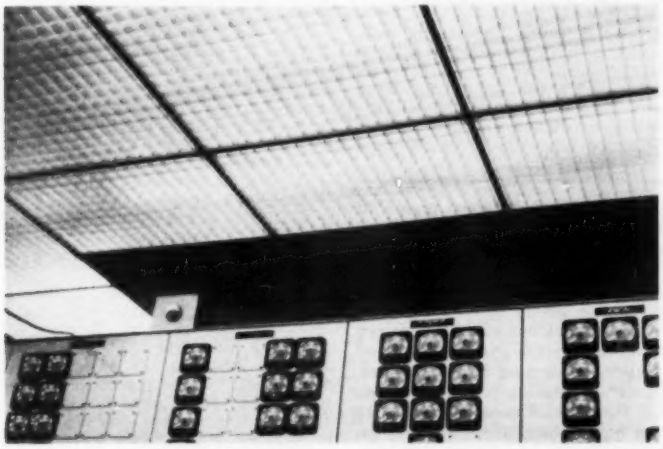


Fig. 1. General view of louver-all ceiling as installed in main control room at Gilbert Station of New Jersey Power & Light Co. showing how uniformity of louver brightness provides good illumination on control panel

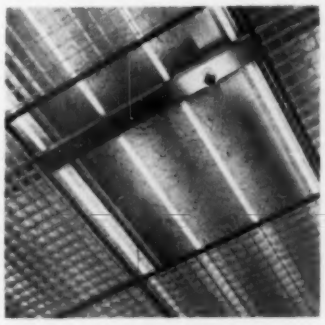
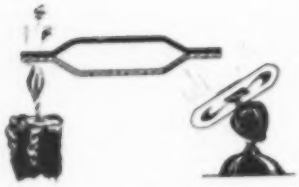


Fig. 2. Detail of Gilbert Station louver-all ceiling. This shows wire duct with sockets on sides and fluorescent lamps mounted at right angles to and between ducts, contrary to usual practice. Ballasts in room above ceiling. Incandescent lamp on bottom of duct for emergency lighting

Soundproofing material was placed on the ceiling; and all exposed metal was painted flat white. Reflectors were omitted above the lamps; thus the entire ceiling area acts somewhat as a large coffer. Excellent uniformity of louver brightness is thus obtained.

Lamps used are 4500-deg., white, 96-in. T-8 slimline lamps, operated at 200 M.A., used throughout the installation. They provide an "in-service" intensity of 85 foot-candles at desk height. Incandescent 60-watt bowl-silvered lamps are placed at strategic locations on the bottom of the duct to provide emergency illumination. The incandescent lamps provide 5 foot-candles of intensity for emergency illumination.



Minimizing Heat Losses in a Thermoelectric Generator

A little over a year ago, in the August 1949 issue, Curtiss Bassett presented an article outlining the design of a possible thermoelectric generator utilizing a thermocouple made of carbon and silicon-carbide. Preliminary calculations indicated that if this type of generator could ever be constructed it would have high efficiencies and could revolutionize our whole method of producing electric power. Subsequent study showed that the design of such a generator was beset by a great many difficulties but that methods might be evolved to overcome some of these difficulties. In January of this year we published another article on this subject by Mr. Bassett, concerning these problems, and now, in this article, he describes his further studies in this direction. Admittedly, the difficulties are great but if this type of generator could be developed along with a method of heating it by means of nuclear energy, our future power problems would not need to worry us any longer. We present this latest discussion by Mr. Bassett for your thoughtful consideration

IN JANUARY of this year in a review of methods for improving the efficiency of proposed thermoelectric generators, a method first suggested by Denzig was discussed briefly. Under certain conditions very high over-all efficiencies, on the order of 80 percent, are possible with this generator. It is the purpose of this article to discuss this method in greater detail and to present one technique for its possible development.

The design of a thermoelectric begins with the assumption of a certain heat loss by conduction from hot junctions to cold junctions in percent of the desired generator capacity.

Considering a 500-kw generator, for example, the conducted heat loss can be assumed at 10 percent or 50 kw. If the 500 kw is power delivered to the switchboard through a d-c to a-c converter having an efficiency of 90 percent, the power delivered to the converter must be 555 kw. Add to this a 20 percent heat loss due to the Joule effect (I^2R) in the generator conductors plus the 10 percent conducted heat loss, and the total power which must be delivered to the generator in the form of heat energy is 716 kw. One other loss to be added at the end of the initial calculation is the electrically conducted heat loss at the cold junction, due to the Peltier effect.

To begin with, assume the 50 kw conducted heat loss is rejected at the cold junctions of a thermopile, these junctions having an operating temperature of 100 F. The hot junctions will operate at 500 F. The thermocouple materials are graphite and silicon-carbide, both refractory materials which develop a high thermoelectric emf as shown by the performance curve in Fig. 1.

From Fig. 1, for a hot junction temperature of 500 F (260C) the emf developed per couple is 0.08 volts. In order to develop 125 volts in this themopile it is necessary, then, to have 125/0.08 or 1563 thermocouples in series.

The 50-kw heat loss is equivalent to 170,600 Btu per hr. From Table 1 the heat conductivity of silicon-carbide and graphite respectively is 6.3 and 9.435 Btu per hr per sq ft per deg F per ft. The size of each conductor from hot junction to cold, for simplicity, will be such that each will conduct the same amount of heat. In other words the silicon-carbide conductor will have 9.435 ÷ 6.3 or 1.5 times the cross sectional area of the graphite conductor. The length of each conductor will be taken as 6 inches.

The required area of silicon-carbide is found to be $170600 \div 2 \times 6.3 \times 400 \times 0.5$ or 67.7 sq ft. For graphite it is 45.2 sq ft. Each silicon-carbide conductor will then have a cross sectional area of $67.7 \times 144 \div 1563$ or 6.24 sq in. Each graphite conductor's cross sectional area must be 4.16 sq in.

From Table 1 the electrical resistivity of silicon-carbide and graphite respectively is 0.0331 and 0.000311 ohms per cu in. Thus the resistance of one silicon-carbide conductor will be $0.33 \times 6 \div 6.24$ or 0.0318 ohms. The resistance of one graphite conductor is 0.00045 ohms. Per thermocouple it is then 0.03225 ohms, and for the thermopile it is 1563×0.03225 or 50.4 ohms.

The power developed and the current flowing in the thermopile may be calculated by substitution in the two familiar equations:

$$P = EI$$

$$0.20P = I^2R,$$

the coefficient 0.20 being the 20 percent Joule heat loss to which the design is limited. The current is found to be 0.5 amp, and the power, 62.5 watts, a very small part of the desired total.

The Peltier heat loss may be calculated from Equation 6 of Ref. 2:

$$Q = PTI \text{ per thermocouple.}$$

This gives a loss of $0.0003 \times 533 \times 0.5 \times 1563$ or 125 watts, twice the useful power.

Superimposed upon the thermopile whose performance was just calculated is another thermopile operating at higher temperature. Its cold junctions are adjacent to the hot junctions of the above thermopile and, being somewhat hotter (50F), radiate heat thereto, the amount being the 50 kw conducted heat loss plus the 0.0625 kw power increment plus the 0.125 kw Peltier heat loss or 50.1875 kw. This is the

conducted heat loss for the second thermopile.

It is now possible to calculate the performance of the second thermopile and then a third, etc. In each succeeding case the conducted heat loss will be larger by the increment of useful power removed from the thermopile of next lower temperature. The final thermopile will then be that one which will conduct 716 kw of heat from hot junction to cold minus a certain increment which will become useful power.

The performance of the final thermopile may be calculated in a manner similar to that of the first thermopile. For simplicity, assume that 716 kw is the conducted heat loss. From Table 2 the increment of useful power is seen to be 30.463 kw.

An average of the first and the final increments of useful power is 15.26 kw per thermopile. The required number of adjacent or superimposed thermopiles is thus 500 ÷ 15.26 or 33. The average temperature difference between hot and cold junctions for each thermopile is

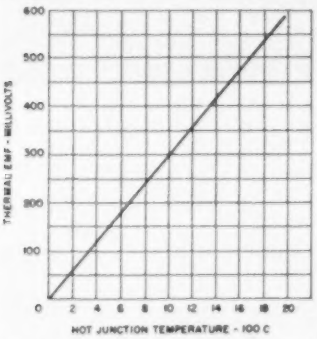


Fig. 1. Hot junction temperature—Thermal Emf relationship of the graphite-silicon carbide thermocouple
(Cold junction temperature constant at 18 C)

10225 deg F including the temperature drop (50 F) required for radiation between the cold junction and hot junction of adjacent thermopiles. The required temperature of the hot junction of the final thermopile is thus, 33 × 10225 + 100 or 337,525° F.

Is this a ridiculously high temperature? At first blush it certainly seems so. No doubt, with controlled release of nuclear energy the actual temperature is theoretically possible to attain; however where are the materials that can stand such a concentrated heat? The answer is, of course, that no known materials can possibly withstand this temperature under ordinary conditions. Will they withstand such a temperature under any conditions?

The answer is probably "Yes." The answer is modified because no experiment at this high temperature nor at any temperature within 100,000 degrees of it has been performed with the specific object in mind of making a material withstand this heat concentration.

Table 1. Average Properties of Thermocouple Materials

Property	Silicon Carbide	Graphite	Units
Heat Conductivity	6.3	9.435	Btu/hr/sq ft/°F/ft
Electrical Resistivity	0.0331	0.000311	Ohms per cu in.

Table 2. Thermoelectric Generator Performance

Thermopile	Temp. Cold Jctn °F	Temp. Hot Jctn °F	Conducted Heat Loss KW	Useful Power KW	Peltier Heat Loss KW	Emf per Couple Volts	Current Amps
1	100	500	50	0.0625	0.125	0.08	0.5
2	550		50.1875				
33	317525	337525	716	30.463		3.308	243.7

A great volume of work has been performed, however, in the physics of high pressures, tremendously high pressures. Some of the more interesting results of this work as far as the problem at hand is concerned may be summarized in three statements:

1.) There is no evidence that there is a critical point between solid and liquid. Any substance can be prevented from melting at any temperature, no matter how high, by the application of sufficiently great pressure. Ref. 3
2.) In general the rise in electrical resistance with temperature can be offset by the application of pressure. Ref. 3
3.) The effect of pressure on thermoelectric emf is very slight, however in general emf increases with pressure. Ref. 4,5.

Since there has been no experimental work performed in this country on either of the thermocouple materials used above, viz. silicon carbide and graphite, it is not possible to predict quantitatively with any accuracy what pressure would be required to preserve these materials in their solid state at the high operating temperature of the above thermoelectric generator. Any equation of the curve of melting point vs pressure presented in any of the high pressure literature is dependent for solution upon constants determined from experimental data.

It is not impossible, however, to hazard a guess. Bridgman, for instance, states that "under temperatures as high as those suggested this pressure would be of astronomical magnitude for ordinary solid substances." This is true because of the nature of the curves of melting temperatures vs pressure for those materials investigated. In every case the slope, change in melting point temperature over change in pressure, of these curves is small; and there is no reason to expect something different from either graphite or silicon carbide.

Among the substances investigated by Bridgman (Ref. 5) the smallest effect on the melting point was noticed on lithium. It rose only 6.7 F for an increase of almost 1000 atmospheres in pressure. The largest effect was noticed on camphor, 234 F for 1000 atmospheres increase in pressure. Even if the latter value were true of graphite and silicon carbide, the required pressure to maintain these materials in the solid state would be around 21 million psi.

Is this value unattainable? Is the case of a practical thermoelectric generator hopeless? These are questions beyond the scope of this paper, written more to pose the problem. The goal is rich. For instance, the over-all efficiency of the generator described above was 500 ÷ 716 or 70 percent, nearly twice as high as is now possible in our most advanced generating stations.

There are other problems along with that of pressure to consider about this generator. Assuming the possibility of attaining the enormous temperature and pressure required above in a nuclear reactor, what would be the effect of introducing silicon carbide into the normal carbon pile?

The entire problem should be investigated initially by designing for a higher conduction heat loss than 10 percent and a lower efficiency than 80 percent. This would lower the ultimate requirements of temperature and pressure. These requirements would be eased even more by an increase of the Joule heat loss due to the electrical resistance of the conductors, particularly in thermopiles operating at higher temperatures, since this Joule heat could be recovered in the thermopiles operating at lower temperatures.

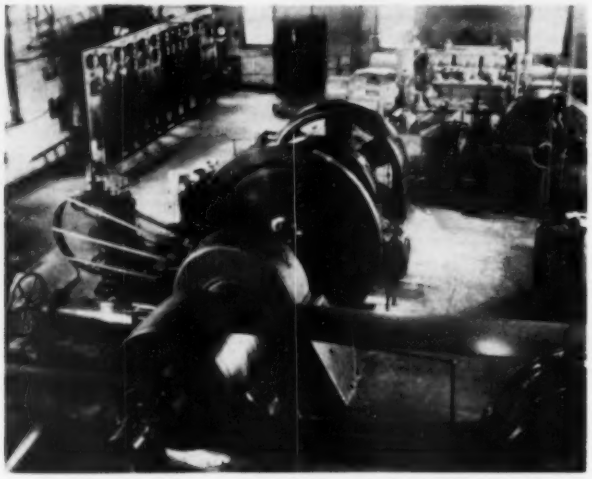
Some attention should be paid to the amount of pressure which is required to prevent expansion of the thermocouple materials and whether it will approach the required pressure for stability of the material. If not then further compression of these materials will be necessary under operation.

Whether the various kinds of radiant energy other than heat from the fissionable fuel would be converted into electrical energy in such a generator is something that no one knows nor will know until one is operated. If they were, again the ultimate operating temperature and pressure could be lowered, with an

(Continued on page 106)

Power Engineering

Here's the test floor set-up at Allis-Chalmers for testing their recently developed pump-turbine, which is reviving interest all over the country in pumped-storage hydroelectric power development. This is because of the obvious economy of a single efficient unit that will pump water into a reservoir with off-peak power and then generate valuable power from that water during peak load periods. In testing pump-turbine, two identical units are used, one being tested as a pump, other as turbine. (P.E. July, 1950)



Aspen, Colorado, has recently become famous both for the Goethe celebration last year and for its present activities as a center of art, music, drama and the like. Here is power house of Mountain Utilities Corp., supplying Aspen with electric power, generated primarily by the impulse-type hydraulic turbines in foreground, but with a Caterpillar Diesel set in the background for standby.

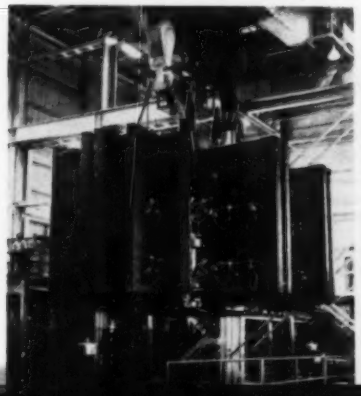
This may not be biggest pipe in the world but it'll do until a bigger one comes along. It is the 25-ft-diameter reinforced-concrete Soap Lake Siphon, a feature of the Columbia Basin Irrigation project in Washington. Walls 23 in. thick; lined with 1/4-in. steel plate; will carry water to irrigate more than 250,000 acres

NEWS REEL

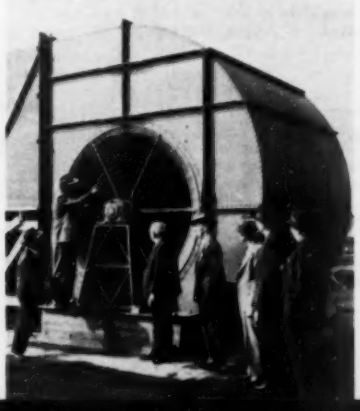
Engineers of Erick Floor & Associates and Allis-Chalmers Mfg. Co. inspecting interior of one of three 62,000-hp hydraulic turbines for Bull Shoals development. Floor is consulting with U. S. Corps of Engineers on several of their projects

Not a great rocket-launching installation but the famous Hungry Horse Dam of Bureau of Reclamation on Flathead River in Northwestern Montana. Nearly 500,000 cu yd of concrete now in place. Tubes are penstocks leading to power plant (in foreground) which will produce 285,000 kw. Stored water will increase firm power capacity downstream by 1,000,000 kw

Anderson Ranch Dam of Bureau of Reclamation on Boise River, world's highest—340 ft—earth-fill dam; two 13,500-kw hydroelectric generators



This 100,000-kva, 138,000-v transformer, first of four for the Union Electric Co., is largest in physical size ever built by General Electric



One of 53 Sturtevant fans for the Brooklyn-Battery tunnel. Each 281,000 cfm

The Penetron and the Probolog — Two New Devices for Inspecting Tube and Pipe

TWO NEW INSTRUMENTS, the Penetron and the Probolog, have recently been added to the power engineer's and the maintenance man's arsenal of weapons for forestalling tubing and piping failures.

The Penetron, utilizing gamma radiation, enables the engineer to inspect, by non-destructive methods, the thickness of tube and pipe walls, especially to discover reductions of wall thickness with service. It does not, however, show the presence of scale, nor of pits or holes in the tubes.

The Probolog, an electromagnetic device, enables him to determine, also by non-destructive methods, the condition of the metal in the tubes—that is, whether there are holes or pits or other wasting of tube metal. It was developed especially for testing heat exchanger and condenser tubes. The Probolog graphs its findings on a chart as it operates.

Both these instruments were developed originally in the oil refinery field, where operators face the same problems of non-destructive tube and pipe inspection, to forestall shutdowns and failures and save time during scheduled outages, as in the power industry.

Both the Penetron and the Probolog are designed primarily for testing of the tube metal itself. There is, however, another instrument designed for measuring the thickness of scale in a tube, without regard to thickness of tube wall or composition of scale. That instrument is the scale thickness indicator, also an electro-magnetic device, described in the article Forestall Boiler Tube Failures by Using This Scale Thickness Indicator, *Power Generation*, June 1949.

To this latter device may now be added the Penetron and the Probolog described below, giving the power engineer and maintenance man the same kind of help the physician and surgeon get from certain instruments for inspecting the recesses of the human anatomy. Now the power engineer can examine the anatomy of his equipment in place, as does the physician, to determine whether or not an "operation" is necessary. Read below how these instruments work and are used.

The Penetron

By
ANDRIES C. deWILDE,
Research Department
The Detroit Edison Co.

MAINTENANCE ENGINEERS in steam-electric power plants are constantly faced with the problem of trying to determine, by inspection, the condition of the tubing in their steam generators, particularly the reduction in wall thickness with service. Because of the limitations of visual inspection, tubes are often removed that are still serviceable, as revealed by later dissection and examination. On the other hand, tube ruptures have occurred unexpectedly. These could have been prevented if an apparatus had been available that would permit actual determination of the wall thickness of the tubes in place. Yet only the external or internal surface of the tubes is accessible; therefore, determination must be made from one or the other surface. The problem is further complicated by the fact that it is frequently impossible to clean the tubes of all scale and slag accumulation.

Any method or apparatus used must permit a survey in a relatively short time, since boiler outages must be held to a minimum.

For many years the oil refineries have been faced with a similar problem, so general and important that extensive research was undertaken in order to develop an instrument that would permit wall thickness determination by a rather simple method. The Texas Co. finally developed such an instrument known as the Penetron, and has made it available to the engineering field.

For the foregoing reasons, The Detroit Edison Co. is experimenting with it. This instrument was purchased from United Engineers of Tulsa, Okla., through which The Texas Co. makes it available.

How the Penetron Works

When you hold a piece of translucent paper in front of a light, you can "see through the paper." Actually, only part of the light from the light source penetrates the paper. It is this light that you see.

Again, the side of the paper held towards the light "shines brilliantly." It is actually the part of the light scattered back from the paper that you observe.

The Penetron operates in much the same way except that the "light" used is gamma radiation from a small amount of radium. Unlike the light, no external source of power is required or material apparently consumed to produce the gamma rays. It takes 1960 years before the quantity of radium is reduced to one-half of its original value.

To detect the gamma rays, special detectors, so-called Geiger Counters, are used. The radium source and detector are built into a frame with a pre-amplifier, to comprise the Penetron head. Two different heads are provided: One head, Fig. 1, is based on the principle of absorption of gamma rays by the walls of pipes when held between radium source and detector. The other head, Fig. 2, measures the back scattering or "shine." The instrument is readily portable, as shown.

Arrangement of the head of Fig. 1 utilizes the principle of absorption. A hollow needle containing radium is placed inside a heavy shield to

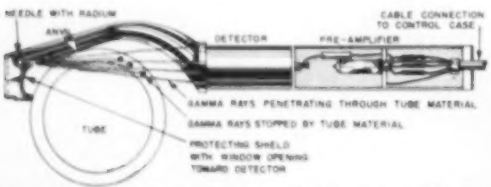


Fig. 1. Principle of measuring tube wall thickness with the Penetron tangential head, using gamma radiation

Fig. 2. Principle of measuring wall thickness with the Penetron standard head, either inside or outside a tube or on a plate

protect the operator. The gamma rays radiate through a window in the shield towards the detector. The gamma ray detector, or Geiger Counter, with a pre-amplifier, "counts" the number of rays and sends this number of impulses to the control case, where the average rate of count is registered on a meter.

If the operator holds the tangential head over a tube or pipe, some rays are intercepted and absorbed by the metal and do not reach the detector. The result is that the meter reading is reduced. This reduction is proportional to the thickness and density of the interposing material. By means of conversion curves, a reading of the meter is converted into a thickness reading.

The wall thickness thus measured is the average over a square inch, because the bundle of rays used

(Continued on page 101)

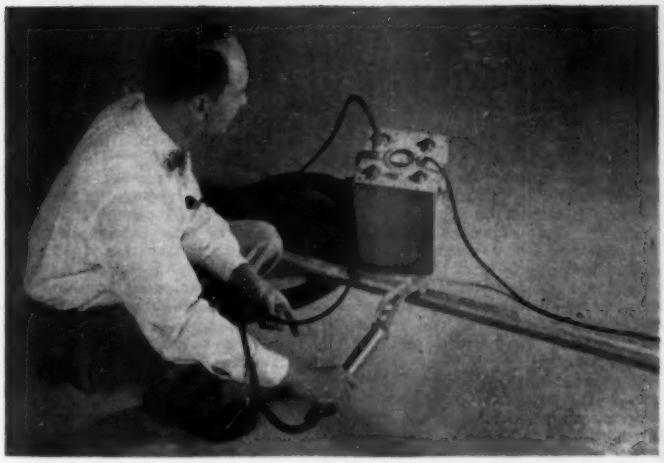


Fig. 3. Measuring wall thickness of a tube with the Penetron tangential head

The Probolog

By M. V. LONG
Engineer
Shell Development Co.

THE PROBOLOG is a completely portable electronic instrument designed for the non-destructive testing of heat exchanger tubing and producing a graphical record representing the condition of the tube being inspected.

In field inspections the probe is first projected by means of an air gun into the tube that is to be inspected, as shown in Fig. 1, taking about 5 sec for a 20-ft tube. The probe puller is then attached to the probe cable and the probe is withdrawn at a uniform rate of either 12 fpm, or 4 fpm, depending upon the speed chosen on the puller and amount of detail wanted on the record. While the probe is being drawn through the tubing, the electronic instrument graphically records the results on a chart moving 12 in. per min; thus a one-inch length of chart will correspond to 1 ft of tubing at the high speed or 4 in. of tubing at the low speed.

Adjusting devices are provided in the instrument, so it can be adapted to varying conditions. The tubing diameter, wall thickness, and material may vary from one piece of equipment to another, depending upon the heat exchange surface required and the operating conditions to be met. The standard tubing sizes vary from $\frac{5}{8}$ in. O.D. to $1\frac{1}{4}$ in. O.D., and range in wall thickness from 8 to 18 gage. The long list of metals and alloys from which the heat exchanger tubing is drawn further complicates the conditions. Materials like aluminum, copper, admiralty, red brass, nickel, and stainless steel are but a few that the instrument is called upon to inspect. To meet this wide range of conditions, a flexible system of adjustments is readily accessible at the side of the instrument case.

How the Probolog Records Defects

To see how the Probolog record graphically represents defects in tubing, let's prepare a sample by drilling holes of known size along one section of a length of good tubing, and reduce the wall thickness along another section. The top of Fig. 3 shows us how this record would appear.

At the bottom of Fig. 3 is the life record of a tube in actual service.

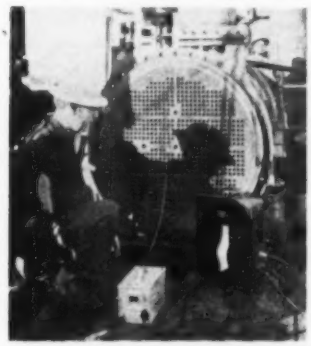


Fig. 1. The Probolog probe is shot through a heat exchanger tube, then pulled out at constant speed, producing type of record shown in Fig. 3

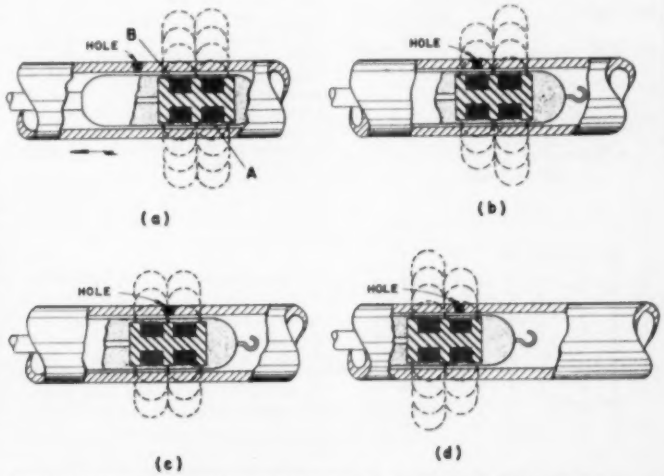


Fig. 2. Electromagnetic probe of the Probolog in 4 positions, showing how presence of hole changes magnetic field, varies impedance of two coils, which form lower legs of an impedance bridge, Fig. 4

At the left we see the record of the tube after it has been in service about six months. The regular pattern of deflections is an indication produced as the probe passes the baffles—not an indication of holes. These deflections provide very convenient space markings for later reference. The center graph represents the same tube after 19 months of service and the third chart represents the same tube at the end of 30 months. Let us assume that we have inspected a statistical sample of the tube bundle and the graphs shown are representative of that sample. At this point the question that arises is just how bad is the condition indicated and should the unit be retubed.

The experienced operator could answer this question quite accurately by simply knowing the type of material and the instrument range settings; but when, at this point, a decision involving thousands of dollars in retubing costs must be made, the wise and conservative thing to do would be to remove two or three of the tubes graphed and to split them for visual inspection. A correlation of the record with the pits and holes found visually will form a very practical basis for a decision.

How the Probolog Works

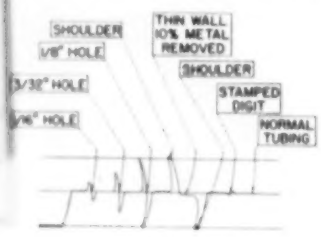
What are the underlying principles and inner workings of the device?

Fig. 2 shows a cutaway view of the probe as it appears in use. A and B are the coils, while the inner section shown shaded is the core. Dotted lines around the coils and emanating from the core flanges, represent the magnetic field produced by the 1000-cycle alternating current flowing through the windings. The fields are similar and not affected by the hole at the left. Both probe coils are located opposite a good section of tubing. Now draw the probe through the tube to the left, as in (b) Fig. 2. The hole is now opposite coil B and the field has been distorted. A measurement of the coil impedances would reveal that the impedance of coil B was greater than it was in position (a) and greater than that of coil A. As the coil continues to move to the left, when the hole is half way between the two coils as in (c), the two fields appear the same. However, our measurement would indicate that the impedance of both coils had increased slightly. As the probe moves on to position (d), pattern is about the same as in (b), but with the relative coil positions reversed. In this position, impedance of coil A is higher than coil B, or the reverse of (b).

The two probe coils are the bottom half of an impedance bridge and the instrument records the direction and amplitude of the impedance unbalance, hence as the probe passes the hole, the pen first swings to one side, returns to center, and then swings to the other side.

Figure 4 is a simplified block diagram of the instrument and probe. The probe forms the bottom half of an impedance bridge, the top half of which is made up of a fixed condenser and the motor driven balance condenser. A low voltage source of 1000-cycle current is supplied from the instrument for exciting the bridge. The bridge unbalance voltage or error signal appears between points a and g in the bridge network, and is applied to the input of the electronic amplifier and discriminator system. This discriminated and amplified signal drives the Dynapoise motor to mechanically position the bridge balance condenser until the error signal approaches zero, at which time the bridge has reached electrical balance. This motion causes the pen, attached to the condenser, to graph the chart record.

The Probolog instrument is built by the Foxboro Co. for Shell and is a modification of their Dynalog recording system.



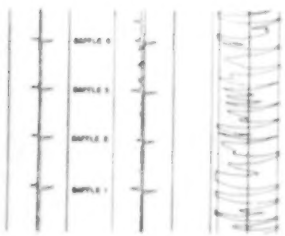


Fig. 3. Above—Type of Probolog chart record produced by hole in tube. Below—Records of Probolog inspection as explained in text

Now Comes the $64 Question

How will this instrument make or save us money? Several users throughout the world have informed us that they have saved more than the expenditure for the Probolog in their first field inspection. More than the cost of the instrument was recovered through savings in tubing alone. In these reports no credit was taken for time and labor saved or for an improved utility factor. One large corporation reported that they were able to reduce their capital investment in spare heat exchanger bundles by as much as 30 per cent, and at the same time maintain a higher on-stream factor.

Within the Shell group, large financial savings have been reported through the establishment of more efficient and systematic maintenance procedures made possible by the use of the Probolog. Removing the guesswork and the "my opinion" type of information from inspection records and replacing it with test records has made it possible to schedule the maintenance of heat exchange equipment. Record of the progressive rate of deterioration of heat exchanger tubing has, in some instances, indicated alterations in equipment for greater production and large savings.

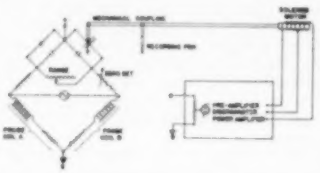


Fig. 4. Simplified diagram of impedance bridge operated by Probolog probe to actuate recorder

Of many reports of the successful and economical use of the Probolog, none shows greater potentiality in savings than those of the electric steam power industry. The outstanding work of Dr. Basquette and his co-workers of the Southern California Edison Company exemplifies how to attack and solve some of the difficult corrosion problems in the power industry today.

The caption, "Probolog inspect and submit records as proof of quality of material and workmanship," is being found more frequently on orders and specifications for new heat exchangers and condensers——desirable for both fabricator and purchaser, as it serves as an excellent final inspection record and as a future reference.

The steamship companies, the shipyards, and the United States Navy have made good use of the Probolog in the inspection of steam condensing equipment and condensers in large refrigeration units on shipboard. Of importance to them is the assurance that, when a ship leaves its home port, it will be able to return without condenser failure or an expensive retube job in a foreign port.

When ships are carrying costly cargos of refrigerated and frozen foods they must not have refrigeration system failure during the voyage. Regular Probolog inspections of the refrigeration condensers insures against these failures, and helps prevent loss of perishable cargos.

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

GETTING AT ROSENSTEIN'S VALVES

In the July issue, Mr. Rosenstein pleaded guilty to the charge of locating valves in the terrible places we sometimes find them. He did it, he said, with his little pencil, but at the same time he passes the buck to the so-called supervising engineers, chief draftsmen, checkers, etc. who, he implies, really are responsible.

Be that as it may, the valves are in the God-awful places we find them, and once Mr. Rosenstein marks the spot on his drawing there is nothing left for the operator but to try to reach that valve somehow, either by acrobatics or by ingenuity. One gets tired of acrobatics so the logical thing to do is to figure out some way of getting at these valves without straining one's sacroiliac.

This is not so difficult as might be supposed because there are a number of gadgets available, or that you can make, which will help you to overcome the distorted geography of these valves. As a matter of fact, it is often desirable and necessary to place valves in locations remote from convenient operating positions and in such instances the remote control of the valves becomes a specific factor in the design of the system.

Rather than give the secret of doing these things away here, we refer you to the opposite side of this page where you will find it all explained very clearly. We only hope that this article will not lead Mr. Rosenstein to completely throw discretion to the winds and mess things up even more than they are.

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A Section of Power Engineering Devoted to
PLANT OPERATION AND MAINTENANCE
Technical Publishing Company
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Fig. 1. A chain wheel on a large overhead valve may enable you to operate it very conveniently without ladders, platforms or taking a roundabout path to the valve

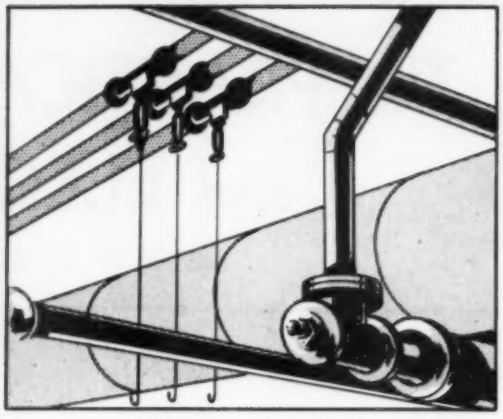


Fig. 2. Extension stems on overhead gate valves are another convenient way of operating the valves from the operating floor without use of ladders or gymnastics

If You Can't Reach That Valve— Use 7-League Gloves

SO, MR. ROSENSTEIN, according to his guilty confession in the July issue, page 53, has obeyed the contradictory commands of chief engineers, chief draftsmen, checkers, purchasers, valve manufacturers and others, and has laid out the piping in your power plant so you can't get your hot, eager, trembling little hands on important valves that have to be operated! Instead, you have to climb all over a maze of piping and make like an acrobat 20 ft up off the operating floor, to get at those important valves. This is the sort of thing the editor, in the May issue, had inveighed against as one of the things that turn power operators' hair prematurely gray.

Mr. Rosenstein says he and the piping designer have to think about piping expansion, flexibility of piping systems, proper flow in the piping and other factors, in addition to obeying all the commands of the assorted brass hats. But Mr. Gleason, in the September issue, says that, even though his heart bleeds for the poor drafsman, who must move those heavy valves and heavy

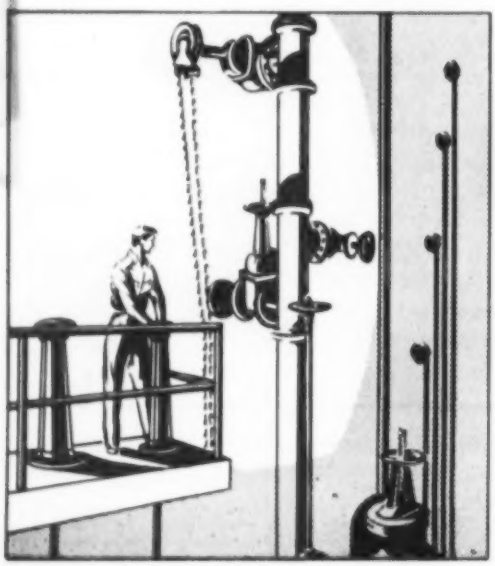
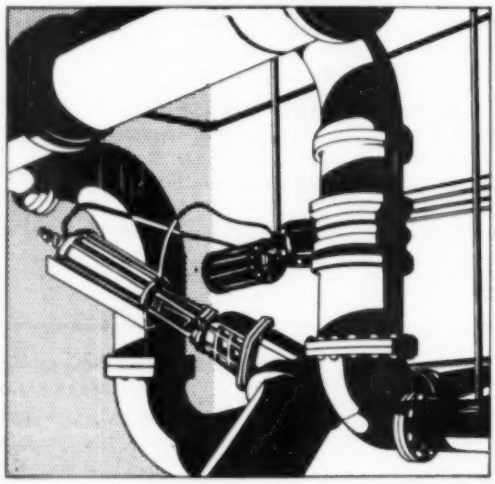


Fig. 3. Left—Unusual combination of extension stems, floor stands and chain wheel on valves in a sewage disposal plant

Fig. 4. Here are two large cylinder-operated gate valves on piping in a waterworks plant. They might also be on condenser circulating water lines or large plant service lines



units of machinery all around the piping diagram, he still thinks it is possible to have good piping design and still put the valves where they can be reached conveniently.

Well, suppose you have a plant all in operation in which all the valves have not been conveniently located by the draftsman sitting in the comfortable seclusion of his drafting room with a mint julep at his left hand, a sun lamp at his right and a soft foam-rubber pad supporting his posterior. There are still a great many things you can do, especially if you use 7-league gloves —in short, devices that enable your hands to reach out to distances much longer than your arm reach; 10, 20, even 100 ft from a convenient position on the operating floor.

By heeding the sapient words of G. W. Hauck, Manager, Engineering Sales of Crane Co., as presented in a recent edition of the *Valve World*, you can use these 7-league gloves to promote ease and speed of operation as well as safety. The accompanying illustrations show a numbers of ways you can do this.

And don't tell us you can't get the money to spend on a relatively simple 7-league glove shown here. You're an engineer, aren't you? So, you know how to make a survey in considerable detail, analyzing the man hours used in running up and down stairways and doing gymnastics to operate the valves. There are often safety factors involved, too, which should be taken into account when it is imperative to have a valve operate exactly right even if that occurs only once a month or once every six months. Even a casual inspection of many piping systems, says Mr. Hauck, will disclose many chances for saving man hours through judicious use of the auxiliary equipment shown here.

For example, in the simple case shown in Fig. 1, instead of using ladders or building a platform, perhaps all you need is the perfectly standard chain wheel which has been used, and sold, and advertised in the pages of POWER ENGINEERING, for more years than we can remember.

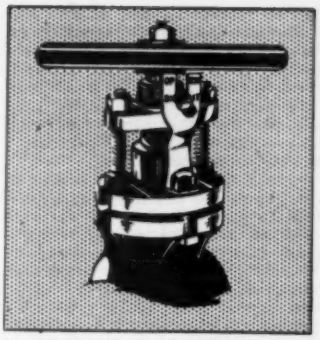


Fig. 5. Here is a simple indicator for non-rising stem gate valves

In other cases, overhead valves, especially in the smaller sizes, can be equipped with extension stems as shown in Fig. 2.

The opposite condition of a valve below the operating floor, involving lost time in reaching it, while neglecting something else that has to be done at the same time, can be cured with a simple extension stem for the smaller valves, or for larger valves, a floor stand. Figure 3 shows an unusual grouping of valves in which, by proper use of floor stands, chain wheel and an extension stem, a number of valves can be reached from the catwalk without too much acrobatics. Absence from the operating floor may be hazardous sometimes, or there may be some risk in getting at an inaccessible valve.

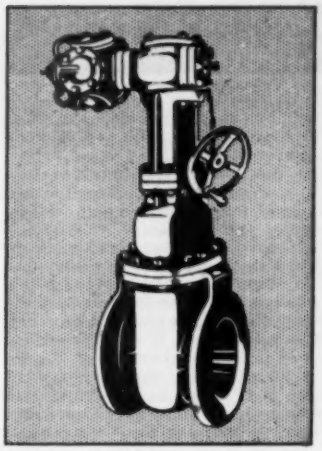


Fig. 6. Mechanical operation for this gate valve can be provided by a fluid-motor at low cost

So much for valves that must be operated either infrequently or at least at reasonable frequency, considering the manpower available and its cost. However, if a valve has to be manipulated frequently, it may be well to consider mechanical operation of it.

This can be done by cylinder operation or motor operation at some distance from the control or operating station. Figure 4 shows cylinder-operated gate valves, Fig. 6 shows a large gate valve operated by a fluid motor, while Fig. 7 shows two large gate valves operated by electric motors.

Choice of operating method depends on relative cost, power available for operation, time cycle for

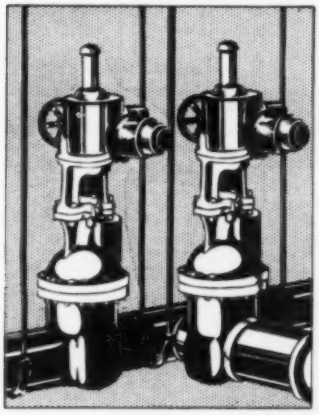


Fig. 7. Large central stations frequently can justify motor-operated valves like this for remote control from a central point

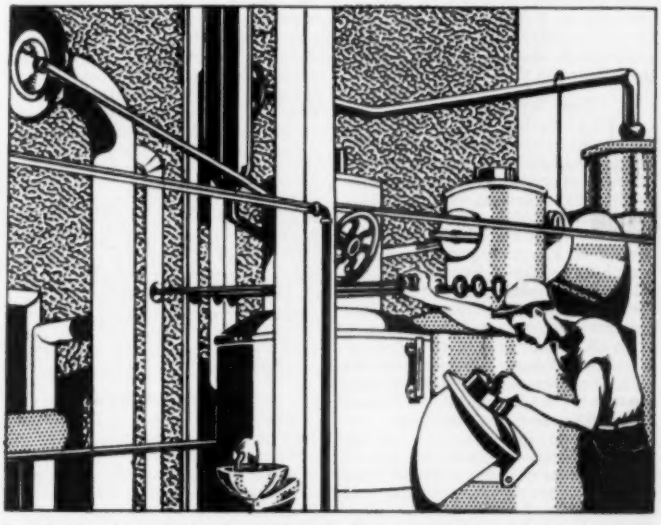


Fig. 8. Here is a mechanical centralization of valve control for an industrial process operator by use of extension valve stems leading to the operating position

opening or closing and the like. High unit cost of labor over several years will often justify an outlay for mechanical operators, to say nothing of the advantages of increased safety, speeding up of operation and the like.

If an outside screw and yoke or rising stem type valve is easily visible, then you can quickly tell whether it is open or closed. However, if it is a non-rising stem valve, you will do well to equip it with a little indicator like that of Fig. 5, inexpensive and easily applied to iron body valves in sizes 12 in. and smaller while in service. You could even elaborate on this with contactors to operate a signal device.

For venting air from water or liquid lines or removing condensate, periodical operation of air vents or condensate valves can be a relatively expensive labor that would justify the use of automatic air vent valves, steam traps and if necessary, remotely operated valves.

One of the most typical errors in the improvised piping systems during the past few years of war and post-war activity has been the misapplication of valves, according to Mr. Hauck. Shortages existed and you had to take whatever valves and piping you could get, even though you knew they weren't right. However, that situation is all over and you can get proper valves and valve operating devices now.

Improper suspension of piping by various expedients adopted during the last war is another common error. Without adequate support, piping can strain joints, distort valve seats and otherwise contribute to maintenance cost. These too can be be obviated by proper suspension materials now available.

On automatic devices and valves, installation of sediment separators may greatly reduce maintenance costs.

Piping varies in individual plants and the above examples are far from a complete list. They merely indicate the type of thinking about valves that may produce many economies in operating piping systems.

Make your survey detailed and analytical and work it out for your management in terms of dollars and cents and you will often find that the 7-league gloves will pay off handsomely over a relatively short time.

Carbon Residue in Fuel Oil

In this, the seventh of Mr. Schmidt's articles on the characteristics of fuel oil, he considers the effect of carbon residue upon the process of combustion. He describes the four types of carbon, the residue in various grades of oil, the relationship between carbon and viscosity and other general relations

By PAUL F. SCHMIDT,
Allied Oil Company, Inc., Cleveland, Ohio

WHEN BURNING and discussing fuel oils, the subject of carbon is frequently included. This specification is sometimes confusing, as there are actually four different types of carbon that can be present, and unless fully understood, will become misleading. The following explanation should help to distinguish between these types of carbon.

Four Types of Carbon

1. Fixed carbon is the carbon of the chemical compounds in the oil, and is obtained by chemical analysis. There is approximately 84 to 88 per cent of fixed carbon in any petroleum product.

2. Free carbon is elementary carbon, that has precipitated or has been knocked loose from the chemical hydrocarbons due to the high temperatures and pressures during the cracking process, in the refining of an oil. This free carbon is present in some residual oils, and will be found floating and suspended within the oil. It is detected as sediment in the BSW test by Centrifuge.

3. Carbon formation on burner tips and walls of furnaces, that is due to the incomplete combustion of the fuel. This is pure carbon, and can be burned away slowly when the combustion becomes correct.

4. The carbon formed during the Carbon test is the fourth type. When a sample of oil is burned in the absence of air, the oil may volatize completely or leave varying amounts of carbonaceous residue. This residue is known as carbon residue, or sometimes erroneously called the carbon content of an oil. Actually this is misleading, as this residue is the amount of carbon remaining after evaporating all the volatile materials. Technically, the carbon content of an oil is the fixed carbon, but this residue from the carbon test is frequently referred to as the carbon content.

A distinction must be made between the residual carbon, which forms due to the high carbon content of the oil, and the carbon and soot which form as a result of poor combustion. Unless this difference is recognized between these two types of deposits, you may in some cases be blaming the oil for a condition with which it has nothing to do.

Methods of Testing

The name of the Carbon test that is generally used is called the Conradson Carbon test. In this test, a certain amount of oil is weighed in a porcelain crucible. This sample is then heated by an open flame in a certain type of apparatus which excludes any air. The heating expels all volatile material, leaving only the carbon residue.

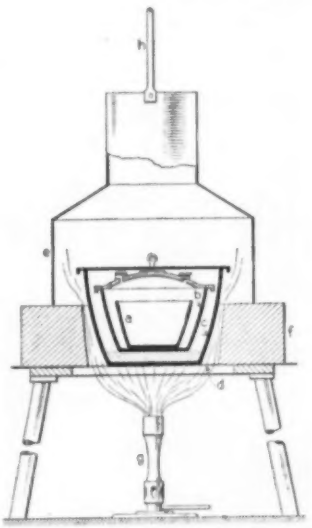
Carbon Residue of Various Grades

The carbon residue varies with the grade and type of oil.

	Straight Run Oil (Per Cent)	Cracked Oil (Per Cent)
No. 2 Oil	nil to .010	.010 to .030
No. 5 Oil	4.0 to 7.0	6.0 to 8.0
No. 6 Oil	6.0 to 9.0	7.0 to 15.0

No. 4 oil is not listed as it is usually a blended oil, and its carbon residue will vary from 0.50 to 6.0 per cent.

According to the standard fuel oil specifications, there is no carbon specification for any of the 4 grades when used as industrial fuel oils. There is a carbon requirement listed



Conradson Carbon Apparatus. The crucible (a) holds the oil sample

for No. 2 oil, but this generally refers to domestic oils. The reason for this, is that industrial installations are not very critical to carbon residue, as long as the proper grade of oil is used.

Oils produced by the cracking process will show a much higher percentage of carbon residue than straight run oils. This is due to the fact that cracked oils are heavier, and lower in gravity, as well as the types of chemical hydrocarbons present are different. These are the aromatic hydrocarbons, of which there are a greater percentage in cracked oils than in straight run. The aromatic hydrocarbons have a greater ratio of carbon to hydrogen, which accounts for the tendency to produce more carbon residue.

When the gravity of an oil becomes lower, the percentage of fixed carbon increases, and the carbon to hydrogen ratio increases. Therefore, as the carbon to hydrogen ratio becomes higher, the carbon forming property of a fuel oil is larger.

Gravity Viscosity Carbon Relationship

There is usually no direct relationship between gravity, viscosity and carbon. Not in all cases, but generally speaking a low gravity oil will frequently have a higher carbon content than a high gravity oil. Also high viscosity oils will have more carbon residue than low viscosity oils. Any variation will be due to the method of refining the oil, and whether or not an oil is blended, and the blending components.

A few illustrations are listed to help explain the above theory.

Gravity A. P. I.	Viscosity at 100F S.S.U.	Conradson Carbon
12.0	3000	10.62
13.4	1025	6.94
15.0	1350	10.02
16.0	1500	6.73
18.0	440	3.66
18.4	1350	7.20
20.0	2450	5.50
22.0	737	5.22
34.0	42	1.68

General Comments

Most fuel oils have a carbon residue that is within the proper limits, and though grades 4, 5 and 6 have large amounts, no trouble should be experienced if the correct grade of oil is used. With industrial burners, the carbon residue is usually not too critical, except in small furnaces or smelting pots where the combustion chambers are small. With burners under large boilers, or with any type furnace with large combustion chambers, the residue content is not too important. No. 2 industrial oils are low enough in carbon to refrain from causing any trouble.

If any carbon trouble appears with any grade of oil, it should first be investigated before blaming the oil. The oil may be of a good grade, but still there may be some carbon difficulty. Usually this is not the fault of the oil, though it could be the wrong grade. The burner, the furnace, and the combustion can all create carbon trouble.

Some burners cannot handle too high a carbon oil, causing carbon formation on the burner tip, which can build up and eventually close the tip opening.

Small combustion chambers will sometimes have carbon buildups on the walls. The oil may not burn completely in these small chambers, or, as it leaves the burners, it strikes the brickwork, and carbon formation results. This condition may be due to the wrong grade of oil.

If the burner is not centered correctly, or if the burner tip is partially blocked, throwing of the atomized oil against the side of the combustion chamber results. This condition is called flame impingement. This carbon formation is not due to the carbon residue of the oil, but rather it is the condensation of the oil vapors or atomized oil on the relatively cooler brickwork, forming carbon deposits.

Too little primary or atomizing air, or too great an oil pressure, can produce incomplete combustion, forming carbon on burner tips or back of combustion chambers.

If the preheating temperatures are too high, there can be carbonization at the burner tips. What happens in this case is that some of the oil is gasified due to the high temperatures, leaving a heavier oil which may have a much greater carbon residue content. Carbonization in the preheater can also result from too high preheating temperatures.

With some types of burners, such as the steam atomizing type, when the burners are shut off, a little oil may leak past the oil valve, and as it hits the hot portion of the burner tip the volatile material in the oil vaporizes, and the residue forms carbon.

In some open hearth burners, carbon formation results due to leaky oil valves. The burner that is shut off can become carbonized, as the leaking valve permits a little oil to seep past, and the opposite burner will vaporize the volatile material, causing the residue to carbonize.

When starting a cold furnace, there may be some carbon formation, but this will burn away eventually as the furnace and combustion chamber become hot.

If the oil is causing carbon trouble, this condition can be eliminated by decreasing the carbon content with blending. Mixing and blending with a No. 2 oil, which has very little carbon, or with any oil that has less carbon than the troublesome fuel, will reduce the total carbon residue content.

Improving Efficiency by Use of Waste Heat

Examples of improved efficiency by utilization of waste heat as recommended by the British Ministry of Fuel and Power during last war may serve to point out some similar improvements in this country

By JAMES O. G. GIBBONS

DURING THE WAR the British Ministry of Fuel and Power published information concerning the economical use of fuel, and gave numerous examples of improved efficiencies gained by the use of waste heat. Since there seems some likelihood of another period of conflict some of these methods may be of interest now. The following examples of the economical use of heat discharged from internal combustion engines are given.

Figure 1 shows diagramatically the method of waste heat recovery from a small 20-kw diesel engine at a plant in Kent, England. The jacket water is connected to the space heating circuit, and in this connection it is pointed out that if hard cooling water is used, it is important that the circuit be a closed one, otherwise the scale deposited in the cylinder jackets will interfere with the heat transfer and cause overheating. The engine exhaust is discharged through an exhaust boiler, and a radiator is installed in the jacket circuit for occasional use when no heating is required.

The heat distribution is approximately as follows. Power 20 per cent, jackets to heating 25 per cent, exhaust to hot water 22 per cent, making a total of 67 per cent.

A much larger installation was made in the Bank of England, consisting of four 300-kw and five 520-kw sets. The jacket water and about half the waste heat from the exhaust go to waste heat boilers, which heat the Bank, and in winter the over-all efficiency is about 75 per cent. In summer the efficiency is lower, but

a large quantity of domestic hot water is required and a considerable part of the waste heat is used in this service. Another example is that of an electric generating plant, driven by internal combustion engines producing 3550 bhp in which the waste heat recovery took care of 51 per cent of the winter heating load, and the whole of the summer load.

Figures 2 and 3 illustrate the changes made in accordance with the recommendations of engineers at a British Paper Mill.

When the plant was first inspected there were three boilers in operation. Engine exhaust at 45 psi was used on the digesters and evaporators, but the condensate could not be returned from the evaporators to the hot well, as it was contaminated with alkali.

Much of the equipment including the evaporators was not lagged, and there was a considerable leakage of steam. Live steam was used on the size pot and the condensate run to waste. It was found that on account of incorrect trapping 37 per cent of the discharge from different sources consisted of uncondensed steam. The dryer was driven by two steam engines but could not take all the exhaust steam, so 1400 lb per hr was blown to atmosphere. The dryers had 15 rolls but only two traps to handle the condensate. The supercalender was not trapped as it was thought that traps would interfere with efficient operation.

The flue gas temperature was 850 F. so in making the changes an economizer (not shown) was installed, and after the following modifications had been made it was found that two boilers instead of three would carry the load. The boiler feed pump exhaust which previously went to atmosphere was used for heating the feed water, but no changes were made at the pulpers.

The digesters and evaporators were lagged and arrangements made for using the exhaust from the evaporators on the digesters. The space heating coils were also trapped.

After the changes were made it was found that there was an excess of exhaust steam, so arrangements were made for using this to heat the

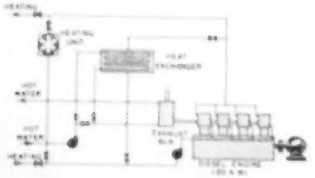
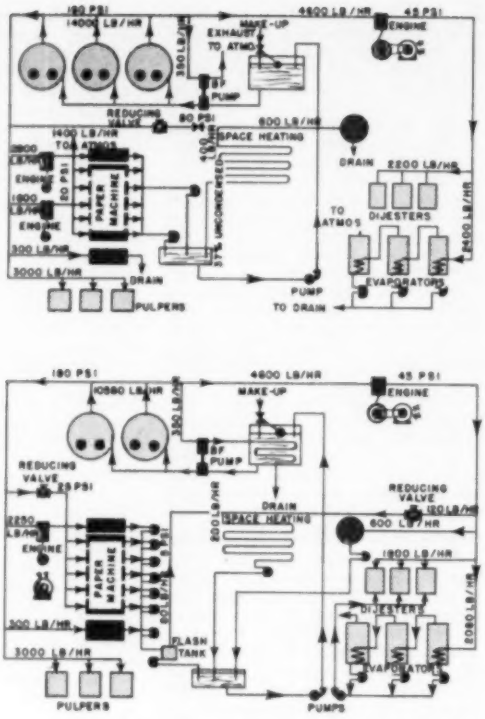


Fig. 1. Waste heat recovery from a small diesel plant

Fig. 2 and 3. Diagrams illustrating the changes made in a paper mill which reduced the coal consumption from 126 to 86 tons per week



size pot, and also for supplying the space heating coils. Flash steam from the dryer was also added.

The changes on the paper machines reduced the steam consumption from 2800 lb per hr to 2250 lb per hr, and to avoid wasting excess steam, one of the engines was replaced by an electric motor, taking current from the mains. The more efficient handling of the condensate reduced the power required by the dryers from 100 hp to 92 hp. A trap was installed on the super-calender as it was found that it interfered with the operation.

After these changes had been made, the coal consumption was reduced from 126 to 86 tons per week, and the make up water from 10,800 lb per hr to 7150 lb per hr.

It may be noted that in a few cases the figures shown do not quite check, but the discrepencies are small and of no practical significance.

KING COAL ABDICATES

By BERT RICHARDS

LATELY WE HAVE noted a number of straws flitting round in the breezes of "event currents." When more closely scrutinized they would seem to indicate that at least one royal personage is about ready to abdicate his top position as America's Number One power source. King Coal is sick, and Dr. Lewis, the court physician, didn't improve matters any during the past year. Thousands of former loyal subjects have openly hoisted the rebel flag, eagerly inviting some other potentate to step up on that throne, temporarily at least. Already there are four husky ambitious eligibles with an eager eye on the royal parking space, gas, oil, watts, and that lusty infant—the electron.

I recently cased a big city from about two thousand feet nearer heaven on a cold day, and in three minutes counted five hundred signal smokes lit by Chief Nuisance and his warriors. More recently we read of active warfare by civic authority on the same renegade tribe, the primary object being the elimination of visible smoke. Action is to be taken against any offender who emits smoke beyond a certain Ringelman density as laid down by statute. Yet that same program leaves the *invisible* poisonous combustion products to carry on scot-free. Every coal-fired plant burning either anthracite or bituminous, discharges a certain percentage of fuel into the air which we breathe, as fly ash and soot, and as carbons monoxide and dioxide. Besides the nuisance value and threat to health, scientists do declare that most of London's famous fogs are due to smoke; it is worth some effort to kill the stinker.

For years, during vacant moments I have dreamed of sealing up coal mines which are past their production prime, firing them and pumping the gas to customers. True, the large sized pipelines would be costly, even as those Big and Little Inch oil pipes from Texas to Linden, or Leduc to Port Arthur, but elimination of railway gondolas, coal trucks, wheelbarrows, conveyors, and finally of *smoke* is worth it.

The great West is pretty well taken care of by its own supplies of natural gas, even when teeming industry settles there, as we will no doubt live to see. At the same time artificial fuel from coal mines could nearly satisfy Eastern needs.

Diesels, which use oil without distillation, and gas turbines bid high as a factor in our immediate power needs. Diesels are still somewhat cumbersome but they are efficient and constitute an ideal type of prime mover in many services. The gas turbine is still new but now that some of the metallurgical problems have been solved they offer wonderful possibilities and they will become larger in the years immediately ahead.

Electric energy consumption has doubled during each of the last three decades and still the demand continues. More and more steam stations have been built because there has not been enough easily available hydro power to go around. Recent headlines announce that work will start soon on projects to utilize more Great Lakes water on its way down Niagara and the St. Lawrence, none too soon either. From an engineering viewpoint, falling-water potential not used is just shortsighted, criminal waste.

Men in a position to know what they are talking about, say that it is feasible to transmit current ten times the present hundreds of miles by cable, and that we will live to see it delivered wirelessly. That would bring us millions of hydro-horsepower now beyond reach in remote areas of the continent.

Per horsepower hour as now delivered by Ontario's provincially owned system, the charge is about one half of a cent. Any manager who would maintain stokers and shovels, cylinders and cinders, coalpiles and conveyors, and *smoking chimneys* rather than pay half a cent per hp-hr at a switchflip, should take an elementary course in economics. Just guarantee an infallible supply of current and he is a permanent customer.

Our newest magic, atomic fission, is *actual creation* of a new form of energy, and—taken one step further—of industrial power, from Uranium, U235, and later derivatives U238 and 239. Industry will work on a practical "free energy" basis, all motive power converted into electricity, which is a big hefty child in the teeming electronic family.

As a strictly amateur student, I confidently predict that within the next decade or two we will run autos with a fist-size engine using U240 at the rate of half an ounce a year or so. That a pound of IT will propel the Queen Mary ten times around the world, will drive the biggest plane steadily for a year, and that every house and igloo in Canada will be heated electrically-electronically from central plants.[1] (Smaller electronic plants are not presently feasible because of the massive protection and shielding required.) All this providing, of course, that no one splits things wrong and wipes out every living thing in one sudden stupendous flash.

In the meantime, don't waste smoke. It is a valuable fuel if you can combust it properly, and a darned nuisance when turned loose anywhere. Up and Atom!

[1] Mr. Richard's predictions are his own. We feel he is a little optimistic.—Ed.

PRACTICAL HINTS AND KINKS

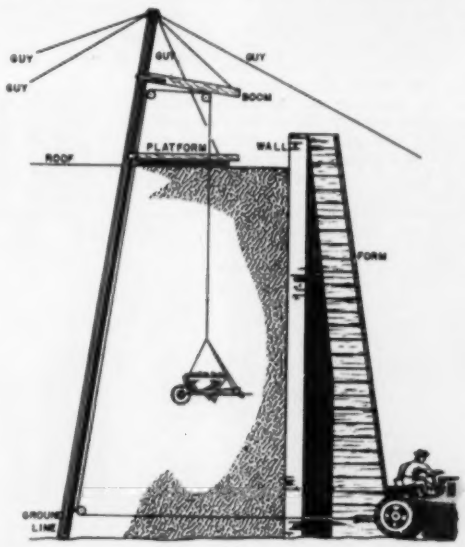
EMERGENCY HOISTING OF MATERIALS

By H. B. McDERMID

IN WORKING ON the erection of power plants, it very often happens that considerable amounts of materials must be hoisted in places where no power hoists of any kind are available. Usually when a job gets along far enough so that permanent cranes are installed, they are found to be the minimum that the operating and maintenance crew can get along with, and the erecting crews are forced to get along with as little as possible. So it is almost impossible to obtain hoisting aid, unless the gang boss knows how to rig his own and can do it with the maximum of safety and efficiency and the minimum of the materials and labor.

Sometimes he may be able to get a "hitch" on some existing high point that will serve his purpose, such as a member of the building framework high above; more often, however, his work is in a barren location, where there is nothing on which a hitch can be taken. In such cases he must supply his own point of support, and about the only thing that is likely to be available is a gin pole. These can be used in many sizes, from light lumber or pipes for use on light loads to giants made of heavy poles, with steel cables for guy lines, or perhaps steel columns set up to lift loads of many tons. But for small weights a very common and serviceable pole is made of sections of standard pipe, often only one or two sections in height, with the sections screwed tightly together.

One example of the use of a moderate size rig comes to mind; it was decided to place five concrete piers along a narrow wall that had started to fall over. The wall was at the end of a lumber storage shed that was held up by two end walls, and



Details of the home-made gin pole

by interior posts, the open sided building having 300 ft. sides and 100 ft. ends. Only one end wall had started to topple, and no part of the building was heavy enough to be of any use in trying to restore the wall to its original position. As a consequence it had to be shored back to place with timbers and jacks, pushing from the ground, below the one story wall. Having gotten it back to a vertical position, the concrete piers were formed up on the outside with proper anchors through the brick walls to insure the two staying together, and vertical, so long as the buttress piers stayed that way. The problem was to get the concrete into the tops of the forms, some 14 ft off the ground, with no equipment, except some rope, and a tractor for power. The gang boss solved the problem with a single section of 2½ in. pipe taken from the stock rack.

Two long ropes, doubled, with clove hitches thrown at the mid point, and placed over the top of the pipe, made four good guy lines, and could be placed quicker than one can read this. A boom was needed so wheelbarrows being hoisted could clear the pole even up near the top, so the gang boss hung a four foot 4 by 4 in. boom under the point where the guys were attached, holding one end to the pipe with a loop of pipe strap and nailed to the two sides of the boom, while a rope at 45 deg held the outer end up, being lashed around the pipe just below the guy lines fastenings. On this boom he rigged a single hoist line running through pulleys at each end of the boom and down to a third pulley near the ground and leading off to his tractor.

All this rigging was done on the ground before the pole was raised, so the work could be done easily and also quickly. When the pole was placed, the guys were adjusted, so it leaned slightly along the edge of the nearly flat roof and a landing platform and runway placed across the 100 ft of roof. The hitch end of the hoist rope had three parts; two rings to slip over the barrow handles and a hook to engage the wheel. The concrete was bought delivered and ready mixed, placed at the foot of the pole. The ground man hooked on a full barrow, the tractor operator pulled it up above the landing platform, where the roof man swung it in over the "spot" and signalled to lower; then he unhooked it and hooked an empty barrow to go down to the ready-concrete truck, using only the single hook for the down trip. There the empty was changed for a full barrow and the cycle began over again. The tractor man was quick and cooperative, and crowded the job along; the rest fell in step and took the job as a new game and really "went to town," keeping the barrows going at top speed, making the concrete contractor happy, and getting the job done in quick time. Someone passed word to the plant superintendent and even he came to watch the gang he'd been told had suddenly gone speed crazy.

After the forms were filled, some 16 yards only, it was a simple matter to take down the rigging, and an hour later nothing remained to show how the job had been done—one of the many advantages of using a light gin pole.

By adjusting the guy lines on such a pole to lean it slightly, the load can be carried sidewise to a considerable degree in any direction. Therefore, if the first setting does not place your load exactly where you want it, a change in location of a short distance can easily be made. The whole pole can also be readily moved by setting the base over a short distance, then adjusting the guy lines to again bring it vertical, repeating as often as necessary. Steel tank crews often move their gin poles from tank to tank in this manner as they build a row of them. They usually have their steel pipe pole with a hole drilled crosswise through it to take a bolt near the bottom, then use a crowbar on each side simultaneously to move it along. A wooden strip can be used for a foundation in soft dirt or sand. Larger poles need larger tackle, not only for hoisting; they often carry rope blocks at the lower end of their guy lines so the pole can be handled with safety.

All in all, the gin pole is a mighty handy tool to the man who needs it and will take the trouble to learn how it should be handled.

MORE TURBINE GOVERNOR TROUBLE

By C. BROOKS HUDSON

THE ARTICLE by Albert H. Moulton in the May, 1950 issue of POWER ENGINEERING regarding the failure of a 5000 kw. turbine generator which failed to take the load recalls to the writer's mind a similar experience, although the trouble was located elsewhere.

Arriving at the plant one morning the Chief found the night operator all in a dither because the 2500 kw. turbine unit which ran in phase with a hydraulically driven generator located several hundred feet away could not be made to carry it's full share of the load.

Fortunately there was sufficient water power to hold the frequency up without loss of load.

The accompanying sketch, Fig. 1, shows the arrangement of the operating cylinder, the piston and valve rods which were screwed into a central connecting piece and held from backing out of place by the two cotters shown.

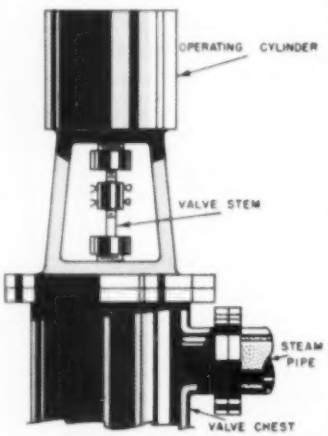


Fig. 1. Arrangement of operating cylinder of turbine governor

After removing his coat and hat the Chief walked around to the operating cylinder, squat down and took a look and called for a pipe wrench, applied it to the valve stem and started screwing it into the center connecting piece. Each turn brought a corresponding pick-up of the turbine load until the governor finally began to function and automatically close off the governor valve as the turbine took its share of the load.

The Chief continued screwing the valve stem into the center piece until the empty cotter holes in the stem again lined up when a new cotter was inserted.

It appeared that there was some slack in the threads between the valve stem and the center piece and as the turbine load changed, the up and down motion of the valve stem brought sufficient strain on the cotter pin to cause it to break and slip out of place allowing the valve stem to screw out of the center piece until it had insufficient travel to allow enough steam to enter the turbine to carry the load.

Here was a case where any operating engineer worthy of the name should have been able to diagnose the trouble and apply the remedy.

Another instance of governor trouble of a more serious nature occurred in another plant and is illustrated in Fig. 2.

The Chief's desk was located in the engine room near the 750 kw. turbine generator, which was running alone at the time, furnishing power to a small street railway system as well as a portion of the power and lighting load in a small city.

A sudden drop in speed by the

turbine was quickly noted by the Chief whose ear was attuned to the musical hum at the correct speed.

Hustling over to the turbine he noted that the stud which connected the governor yoke with the floating lever which positioned the pilot valve admitting steam to the operating cylinder had broken off, putting the governor out of commission

Fortunately there was a frequency

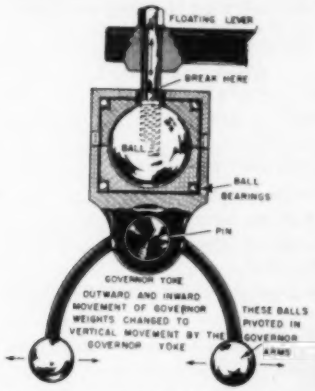


Fig. 2. This governor failed because the stud broke due to corrosion

indicator on the turbine gauge board and the Chief, watching the frequency and operating the floating lever by hand, was able to control the speed closely enough to prevent loss of load until another unit was phased and took over the load.

Since the governor stud and the ball joint connecting it with the governor yoke was well lubricated the Chief was curious to know what had caused the stud to corrode to the point of breakage.

A call to the company supplying the oil brought a service man. His answer was that, at that time, sulphuric acid was used in the refining of lubricating oil and unless all the acid was subsequently removed, the remaining acid would cause corrosion.

This governor design was used for many years by one of the larger turbine builders and perhaps still is, in fact the writer has two turbine units in his present plant with this design but so far has experienced no trouble.

SIMPLE STETHOSCOPE

By C. P. PEROT

VARIOUS DEVICES have been described from time to time for listening to machinery noises. The simplest device I have found, and one that is generally in the pocket, or hand, of a trouble hunting engineer, is a two cell flashlight with a one piece metal case. The ear is placed on the lens and the edge of the bottom touched to the machine under suspicion. By inclining the "stethoscope" somewhere between 15 and 30 degrees from vertical the intenity can be varied to suit conditions. It is admitted that this rod is too short for some conditions and that it should only be used by bald engineers if there are sprockets or belts nearby but it serves very nicely for the majority of cases.

MINIATURIZATION of electronic components has produced some startling contrasts. While conventional magnetron tubes use voltages of 20,000 to 30,000, a new miniature magnetron developed by the Signal Corps uses less than 100 volts. The new tube is four inches long and about the diameter of a lead pencil. *—Ohmite News*

NEW INSULATING TAPE FORMS CONTINUOUS SKIN

LAYERS of a new insulating and splicing tape based on Bakelite polyethylene resins weld into a continuous elastic skin within a few minutes after wrapping around a cable splice (see illustration—top) or tool handle (bottom left). Wrapped around a ping-pong paddle handle and cut a few minutes later (bottom right), the tape is removed in one solid homogeneous mass. The plastic base keeps the self-bonding tape flexible despite severe weather conditions. The tape is unaffected by temperatures ranging from 120 F to as low as 30 deg below zero, F. The seal made with this tape requiring no adhesive material, is a positive, permanent, moisture and airtight seal. It is unaffected by corrosive fumes, ozone, sunlight and oxygen. For application, the tape is stretched to two or three times normal length, then wrapped normally. It is almost impossible to unwrap or delaminate. The tape is extremely useful to industry for insulation and harness wrapping, to bind wires together or to some rigid object. Both clear and black forms of the tape are produced.

Photographs showing how the polyethylene tape welds into a continuous surface after it has been applied

THE PRACTICAL ENGINEER AND ELECTRICIAN

Basic Power Plant FIGURING

By WILLIAM H. ENGELMAN

Mechanical Engineer

Department of Water & Light
City of Cleveland, Ohio

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Engineering Constants

What They Are, Why They Are Tabulated and How to Use Them

DURING MANY YEARS as instructor in steam power engineering and allied fields to the higher type of operating engineers and power-station superintendents, I discovered that on numerous occasions these men had trouble or great inconvenience in using formulas with constants, so frequently found in the engineering handbooks. In using these constants, one must be definitely sure what they are, what they mean, and how they should be applied. Lacking knowledge of the derivations of constants, many questions arise and it often requires considerable time to solve problems and be sure the answers are correct.

This gave me the idea that there was great need for a tabulation of constants, arranged in order of their numerical values so that they could easily be located, and with a description of the derivation of each where necessary.

The questions about these constants may be of the following nature:

a. What do these figures represent in a formula?

b. How have these figures been obtained?

c. What quantities do these figures involve; such as, length, areas, volume, also cubic inches, cubic feet, gallons?

d. What forces or pressures are involved: inches of water or mercury, pounds per square inch or square foot, ounces, kilograms?

e. What time interval has been used: seconds, minutes, hours?

An example will readily show the application.

A centrifugal pump delivers 1,000 gpm against a pressure of 75 psi. Find the water hp by showing the full calculation, by using constants from the tabulation.

$$\text{The water hp} = \frac{1000 \times 8.33 \times 75 \times 2.31}{33{,}000} = 43.76 \text{ Ans.}$$

There are three constants in the problem that can be changed to one. From the table: 1714 represents $33{,}000 \div (8.33 \times 2.31)$

The water hp is

$$\frac{1000 \times 75}{1714} = 43.75 \text{ Ans.}$$

33,000 is the foot-pounds per minute in one horsepower.

8.33 pounds is the weight per gallon of water at 60 F.

2.31 × psi is feet head pumped against.

This example shows clearly that constants properly used save time, also with less calculation there are less chances for mistakes. If you are careful, use them wherever you can, but make notation from which book and what page they were taken.

0 deg C is freezing point of water, 32 F. C is Celsius and Centigrade.

1 is atomic weight of hydrogen.

100 deg C is boiling point of water at standard atmospheric press. 14.7 psi.

10,160 Btu required to burn 1 lb of carbon-monoxide to carbon-dioxide.

10.764 sq ft is one square meter. 1.19599 square yards.

1.0855 is relative volume of ice to water, per pound, both at 32 F.

1096 is $60 \times \sqrt{2 \times 32.2 \times 62.3/12}$, constant for velocity of air, f.p.m.

0.1134 hp is available water power from 1 cu ft per sec falling 1 ft.

1.12838 × side of square of equal area is diameter of circle.

1.134 ft of water equals 1 in. of mercury, both at 62 F.

1150.4 Btu per lb is enthalpy of dry saturated steam at standard atmospheric pressure 14.7 psia.

11.52 lb is theoretical air required to burn 1 lb of carbon.

12 is atomic weight of carbon.

12,000 Btu per hr is 1 ton of refrigeration.

12.387 cu ft is volume of 1 lb of air at 32 F and standard atmospheric pressure.

1.2407 × cube root of volume is diameter of sphere.

1.2444 cu ft is one bushel or 2150.42 cu in.

12.52 lb is weight of theoretical combustion products from 1 lb carbon.

1,273,239 circular mills is 1 sq in. in area.

0.13368 cu ft is one gal. (231 ÷ 1728): use 0.1337.

1.3414 horsepower is one kilowatt.

14 is atomic weight of nitrogen.

140 Btu is 1 sq ft of direct radiation for hot water heating.

1.406 is ratio of C_p to C_v for air, (constant pressure ÷ constant volume).

1.41421 is the square root of 2.

14.223 psi is one kg per sq cm, that is, one metric atmosphere.

144 Btu per lb is latent heat of fusion of ice at 32 deg F.

1,440 gallons per day (gpd) is one gallon per minute (gpm).

14,540 to 14,600 Btu per lb is calorific value of carbon.

14.7 psi is standard atmospheric pressure (30.0 in. mercury).

1.54723 cu ft per sec is 1 mgd.

16 is atomic weight of oxygen.

0.17 is C_v for air at constant volume, (0.1689 to 0.1710).

0.017138 grams per liter is 1 grain per gallon.

17.14 is the square root of 231 ÷ .7854. A constant in piston pumps.

1714 is 33,000 ÷ (8.33 × 2.31), a constant for water horsepower.

17.153 parts per million (ppm) is 1 grain per gallon of water at 70 F.

1728 cu in. is 1 cu ft or 7.48052 gal (use 7.48).

1.732 cu in. of water is 1 ounce or 0.0625 lb.

1.732051 is the square root of 3.

1.8 Btu per lb is 1 kilogram calorie per kilogram.

1.8 deg F is 1 deg C. (C is Celsius or Centrigrade).

18.016 is molecular weight of water.

180.1 Btu is required to raise 1 lb of water from 32 to 212 F.

1.8047 cu in. is 1 fluid ounce or 29.5737 cc.

1,980,000 ft-lb per hr is 1 hp. (33,000 × 60).

200 Btu per min is 1 ton of refrigeration.

2.0355 in. of mercury at 32 F is 1 psi.

2.0416 in. of mercury at 62 F is 1 psi.

20.91 is per cent of oxygen in air by volume.

2,116.3 lb per sq ft is standard atmospheric pressure.

212 F is boiling point of water at standard atmospheric pressure.

2150.42 cu in. is 1 bushel or 1.2444 cu ft.

2.2046 lb is 1 kg. (1 ÷ 0.4536).

0.002228 cu ft per sec is 1 gpm.

223.7 is square root of 2 × 32.16 × 778.26 (turbine nozzle calculation).

22.412 liter is volume of any gas at standard pressure and temperature.

2.302585 × log to base 10 gives log to base e (Napierian logarithm).

2.3077 ft of water is 1 psi at 62.4 lb per cu ft, (52 F).

2.31 ft of water is 1 psi at 62.35 lb per cu ft, (62 F).

231 cu in. is one gallon or 0.13368 cu ft.

0.24 is C_p for air at constant pressure, (0.2375 to 0.2430).

240 Btu equals 1 sq ft of direct radiation for low-pressure steam.

252.2 calories (small) is 1054 watt-seconds, is 1 Btu.

2.5400 centimeters (cm) is 1 in.

2544.1 Btu per hr is one hp, (1,980,000 ÷ 778.26).

2,656,000 ft-lb per hr is one kilowatt, (44,267 × 60).

2.667 lb of oxygen is required to burn 1 lb of carbon.

2.71828183 is e, the base of the hyperbolic log, (Napierian log).

273.16 deg. Kelvin on the C absolute temperature scale, is the same as OC, the freezing point.

27.71 in. of water at 62 F is one psi. (2.31 ft)

28.0 is molecular weight of carbon monoxide.

28.317 liter is 1 cu ft.

28.34953 gram is 1 ounce avoirdupois.

28.8 is equivalent molecular weight of air.

288,000 Btu per 24 hr is 1 ton of refrigeration.

294 is 231 ÷ 0.7854, a constant in water cylinder diameter for piston pumps.

29.5737 cc is one fluid ounce or 1.8047 cu in.

29.921 in. mercury at 32 F is standard atmospheric pressure of 14.6963 psi.

30.0 in. mercury at 62 F is atmospheric pressure of 14.7 psi.

30.48006 centimeter is 1 ft.

30.1035 gram is 1 Troy ounce, (apothecary).

3.1416 is ratio of circumference to diameter of circle (3.141592654).

32 deg F is freezing point of water.

32 is atomic weight of sulphur and molecular weight of oxygen gas.

32.16 is g, accelaration due to gravity, ft per sec per sec at 40 deg latitude.

3.2808 ft is 1 meter or 1.093611 yards.

33,000 ft-lb per min is 1 mechanical horsepower.

33,475 Btu per hr is one boiler horsepower, (34.5 × 970.3).

33.947 ft of water at 62 F is standard atmospheric pressure of 14.7 psi.

3412.75 Btu per hr is one kilowatt, (2,656,00 ÷ 778.26). Use 3413.

34.5 lb water per hr evaporated from and at 212 F is 1 boiler horsepower.

34.56 lb of air is required to burn 1 lb of hydrogen.

35.314 cu ft is 1 cubic meter or 1.30794 cubic yards.

359 cu ft is molar volume at 32 F and 14.7 psia.

3.78543 liters is 1 gal or 231 cu in.

3.85 is 231 ÷ 60, a constant in cylinder formula for piston pumps.

39.37 in. is 1 meter or 100 centimeters.

3960 is 33,000 ÷ 8.33, a constant for water horsepower.

396,000 in. lb is 1 hp, (33,000 × 12).

3.9683 Btu is 1 kg-calorie, (2.20462 × 1.8).

4,050 Btu per lb is calorific value of sulphur.

4.1888 × radius cubed is the volume of a sphere.

42.4023 Btu per min. is 1 hp, (33,000 ÷ 778.26).

0.4333 psi is 1 ft of water at 62.4 lb per cu ft.

43,560 sq ft is one acre, (208.71 × 208.71 = 43,560).

(Continued on page 84)

BASIC POWER PLANT FIGURING

William H. Engelman Appreciates Sabin Crocker's Comment on Boiler Feed Piping, September, page 83

MR. CROCKER'S discussion is very much appreciated.

As he has pointed out, wide variations in friction head are possible, due to water conditions and age of piping. Perhaps additional emphasis should have been given to this possibility in the original article. Discussion should do much to clarify the point.

The basic reason for the use of Williams and Hazen values based on C = 100 in the calculation is a point Mr. Crocker has brought out. Pump manufacturers and others have published pipe friction data based on this value, although a single table will obviously not be adequate for the range of possible variation.

However, this published material is most readily available to operating men, and was therefore used. In most cases, it will result, it is true, in some oversizing of pump or piping or both. It is "safe" in the sense that pump and piping will be big enough for all but very bad condition, even though it may lead to an excessive safety factor.

Certainly the design of a power plant should be based upon very careful estimates of piping losses, using the best information available. For such calculations a reference such as Mr. Crocker's *Piping Handbook*, 4th Edition, should be consulted.

WILLIAM H. ENGELMAN
Lakewood 7, Ohio

MAKING THE ENGINE RUN STIDDY

By H. B. McDERMID

IN THE DAYS WHEN a good Corliss engine was considered *tops* in prime movers, an engine firm received word that one of its units was not performing satisfactorily. The engine, it was said, was taking too much steam to carry the load, so much in fact, that the boiler was no longer adequate. This boiler had been perfectly adequate originally as had everything else from an engineering standpoint. The engine firm, therefore, decided to send an erecting engineer to the plant to ferret out the trouble.

This small central plant was generating electric power for several isolated irrigating pumps in a southern rice field. It had only one unit operated by a colored fireman-engineer, and ran only through the day shift, thus putting everything about the plant under the complete control of the one operator.

When the engine company man came, he reported he could tell one thing that was sadly wrong, from a half a mile away. Live steam was

blowing straight from the boiler through the engine exhaust valves in a manner that was painful for a trained observer to hear. Arriving at the plant, he found the operator, nearly a physical and mental wreck, trying to keep steam on the outfit. He was about to give it up as a hopeless job. When asked about the valve setting on the engine, he replied "Yes, I changed those rods there" pointing to the valve rods on the Corliss wrist plate. "The feller that put in this engine left it run-

The engine went Wh-oo-sh wh-oo-sh

ning jerky. She'd go Puff-Puff-Puff —and I didn't like that so I fixed it so she'd run stiddy, and go Who-o-o-sh, Who-o-o-sh, Who-o-o-sh, so it sounds more regular."

The erecting man got busy and since he had no particular need to hold uninterrupted service on his lines, re-set his Corliss valves at once, and then decided to run a test of his own. He got up a full head of steam, took on his load which the combination now carried easily, and stayed out of the boiler room in spite of the anguished pleas of the operator who danced around repeatedly remarking, "Boss, if you don't put more coal in her now, you'll never get steam back on her." When close watch on the voltmeter showed the voltage to be dropping because there was no longer steam pressure enough to hold up the speed to normal, he went to the boiler and threw in a good fire. In ten minutes time the pop was blowing off, and the operator could not conceal his amazement at the change that had taken place.

This is typical of the unbelievable situations that sometimes arise "out in the sticks" where often neither the owners nor the operators have any usual knowledge of the profession they are trying to practice.

* * *

FLUID COUPLINGS using metallic powders in a liquid to transmit torque have been developed in this country. However, in Europe, a newly developed coupling uses graphite instead of the liquid. The mixture acts like a powder on starting, then, as speed increases, it acts as a fluid of increasing density, and finally behaves as a solid. Several advantages claimed are: self lubrication, 100% slip over long periods of time without damage, and very uniform speed increase in starting.

—*Ohmite News*

BASIC POWER PLANT FIGURING

(Continued from page 83)

4380 Btu is calorific value of carbon monoxide.

44 is molecular weight of carbon monoxide.

448.831 gpm (gallons per minute) is 1 cfs (one cubic foot per second).

0.45359 kg is 1 lb.

459.6 deg Rankine (R) is absolute ZERO, (minus 459.6 F).

46.91 is $\sqrt{1728 \div 0.7854}$ used in reciprocating pump calculations.

0.47 Btu per lb per deg F is specific heat of superheated steam at standard atmospheric pressure.

481 is 60 × square foot or 2 × 32.16 or 60 × 8.02, (velocity fpm).

0.490 psi is 1 in. of mercury at 58 F.

4.9 is 3.85 ÷ 0.7854, a constant in stroke formula for piston pumps.

0.4912 psi is 1 in. of mercury at 32 F.

5.196 lb per sq ft is 1 in. water at 62 F, (0.03611 × 144).

0.5236 × diameter cubed is volume of a sphere, (3.1416 ÷ 6).

5252.0 is (33,000 ÷ 2 × 3.1416), a constant in Torque.

5280 ft is 1 mile, 8 furlongs, 320 rods, 1760 yards, 63,360 in.

0.53 is ratio of critical to inlet pressure for air and gases.

53.33, a constant for air in the equation: P V = M R T.

0.55 is ratio of critical to inlet pressure for superheated steam.

550 ft-lb per sec is 1 mechanical horsepower.

56.88 Btu per min is 1 kilowatt, (44,267 ÷ 778.26).

57.2957795 deg is a radian, forming an angle of 57 deg 17 min 44.81 sec.

0.575 is ratio of critical to inlet pressure for saturated steam.

57.5 lb is weight of 1 cu ft of ice at 32 F, (55 to 57.5 lb).

0.5774 ounces is the weight of 1 cu in. of water.

58,310 is grains per gallon of water at 70 F.

59.83 lb of water at 212 F is 1 cu ft or 8.00 gal.

61.023 cu in. is 1 liter.

62,000 Btu is calorific value of hydrogen.

0.62137 miles is 1 kilometer or 1,000 meters.

62.355 lb of water at 62 F is 1 cu ft.

63,025, a Torque constant, is 33,000 × (12 ÷ 2) × 3.1416.

6356 a constant in fan air-hp is 33,000 × (12 ÷ 62.3).

646,317 gallons per day (gpd) is 1 cfs or one cubic foot per second.

694.444 gpm is 1 mgd. (million gallons per day).

7,000 grains is 1 lb.

0.7067 Btu per sec is 1 hp, (550 ÷ 778.26).

0.0735 in. of mercury at 62 F is 1 in. of water at 62 F.

745.7 watts is 1 horsepower.

7.48052 gal is 1 cu ft or 1728 cu in. Use 7.48.

760 mm mercury is standard atmospheric pressure at 32 F, (14.696 psi, 29.921 in. Hg)

7.65 lb is theoretical weight of air per 10,000 Btu in the fuel.

76.85 is per cent of nitrogen in air by weight.

778.26 ft-lb is 1 Btu.

0.7854 is 3.1415926$54 \div 4$ equals 0.7853982.

79.09 is per cent of nitrogen in air by volume.

8.0 lb of oxygen is required to burn one pound of hydrogen.

8.02 is the square root of 2 g or 2 × 32.16.

0.080728 lb of air at 32 F and standard atmospheric pressure is 1 cu ft.

8.335 lb of water at 62 F is 1 gal.

8.345 lb of water at 39.2 F (maximum density) is 1 gal.

0.88623 × diameter of circle of same area is side of square.

0.0929 square meter is 1 sq ft.

0.94633 liter is 1 quart.

0.9480 Btu per sec is 1 kilowatt, (2,656,000 ÷ 60) × 60 × 778.26.

970.3 Btu required to evaporate 1 lb of water from and at 212 F.

980.616 cm per sec per sec at 45 deg latitude is acceleration due to gravity.

Questions and Answers

Question No. 473

WILL THIS SHUNT-WOUND GENERATOR FIT HIS CONDITIONS?

IN OUR INDUSTRIAL PLANT, all process equipment is driven by d-c motors to obtain very close speed control on the processing machines. Up to the present time we have been generating most of our d-c power, purchasing the remainder as a-c and converting it to d-c with m-g sets.

Now we have an opportunity to purchase a turbine-generator set with a straight shunt-wound d-c generator, originally built for installation on a U.S. Navy cruiser but never installed nor operated. It is in brand-new condition. We are seriously considering purchasing this unit because it would supply us with low-pressure extraction and exhaust steam that we need for our industrial processes, and with additional electric power, at low cost. Our boilers are designed for a high enough pressure to supply steam to this turbine at its designed throttle pressure and temperature.

Our problem is this:—Up to the present time we have been generating a large amount of our power with steam-engine-generator sets on which the generators are 240-v, flat-compounded, d-c machines. We have five of these units, with a total capacity of 2000 kw. We also have two motor-generator sets of 500-kw each, the d-c generators of which are also compounded.

Now if we should install the turbine generator with the shunt wound, d-c generator and try to operate it in parallel with the compounded m-g set generators and the compounded, engine-driven generators, it seems to us we would have quite a problem in voltage regulation. The manufacturer of the turbine generator has recommended the use of a certain type of voltage regulator, but for various reasons it will not fit very well into our electrical system.

What we would like to know is this: Can we use this shunt-wound turbine-generator set in parallel with the other d-c machines and what type of regulator will give us satisfactory regulation for this parallel operation?

We thought perhaps some Q & A reader might have had some experience in operating combinations of compound and shunt-wound generators in this way and can tell us whether or not it is practical; and, if so, just what type of regulating equipment and methods we must use.

Naturally we want to be pretty sure of this before purchasing the 500-kw d-c shunt-wound turbine generator set. Any help that Q & A readers can give us on this point will be much appreciated.

Chicago, Ill. J. B.

Question No. 474

HOW CAN THEY STOP STACK EMISSIONS WHEN BURNING SAWDUST OR WASTE WOOD?

RECENTLY the editors have received quite a few questions from small manufacturing establishments about burning sawdust or waste wood alone and sometimes burning it on top of coal on stokers. Some of these questions relate to the equipment itself and to the proper methods of burning the wood fuel, but in practically every case they ask about prevention of stack emissions. These questions doubtless arise because the general public is being aroused more and more to demand abatement of stack emissions of all kinds. If a wood burning plant is broadcasting the neighbors with unburned products of combustion and even flaming ones, as in some cases, it is bound to receive complaints from the neighbors.

Most of those who ask questions about this seem to have the idea that there is some kind of a magic device that you can clamp on somewhere to stop all these unburned wood particles and sparks from flying all over the countryside. Yes, there are various types of traps and collectors that will collect this material but we suspect that in most cases that is merely applying a poultice and is not getting at the source of the trouble, which is in the combustion of the wood fuel itself. Not only does wood fuel require large combustion space, but it also requires large supplies of excess air at the proper points and especially overfire air if the wood is burned on any kind of grate or stoker. The air must also be introduced so it produces lots of turbulence in the combustion gases.

It has been our observation, and that of a great many other engineers, that if unburned wood particles and sparks are going through the boiler, that is an indication there is something wrong with the combustion process. The proper method of burning wood and the need for high amounts of excess air in doing so have been well recognized for a great many years and have been treated in considerable detail in the literature.

However, it is one thing to design a new plant properly to burn wood and another thing to take existing plants and remodel them so they will do it satisfactorily and eliminate stack nuisances already existing.

Besides producing a stack nuisance, improper combustion of wood also produces various gases and products from wood that may deposit on refractory and metal surfaces all through the boiler and its auxiliaries and thus increase boiler maintenance.

Below are two of the typical questions received on the above points. Comments on them from Q & A readers will be greatly appreciated.

This Plant Emits Unburned Wood Particles

WE BURN WOOD in our boilers and at present we are creating somewhat of a nuisance or menace in our locality because of sawdust going through the boilers without being burned up entirely. This settles in the neighborhood and naturally people are handing in complaints.

In firing our boilers we carry a small bed of ashes to protect the grates. Practically all of our fuel is sawdust or scrap wood fed to the boilers in the daytime by our blower system.

The sawdust is admitted to the furnaces approximately 30 to 36 in. above the grates. It comes in faster than actually needed to maintain the steam pressure, and a strong draft is required to burn it.

What could we install or what would engineers recommend to eliminate this unburned material going out the top of the stack? At present we have two metal stacks, approximately 50 ft high above the boilers.

Any help you can give us will be appreciated.

Pennsylvania D. C. B.

This Plant Burns Wood Scrap and Coal on Stokers

WE OPERATE three horizontal return tubular boilers, two of 150 blr hp capacity each, connected to one smokestack and one of 200 blr hp capacity connected to a single smokestack.

These boilers burn both stoker coal and wood scrap, both fuels being fed to the stoker from above. When burning this combination of fuels, we get considerable air contamination by a fine flying ash from the stack.

We would appreciate any information you can give us on methods of controlling this flying ash.

Indiana H. L. C.

Answer No. 466

HOW MUCH STEAM DO THESE HEAT EXCHANGERS SAVE?

IN OUR finishing plant, said H.A.W., August issue, we heat wash water for continuous cloth washers. The hot water overflows continuously. For some years we have been wasting this hot wash water. Now we have installed heat exchangers to reclaim heat from the wash water to heat incoming fresh water. We now want to figure how much steam we are saving by using heat exchangers.

Water in the wash boxes is heated

by live saturated steam at 100 psig. The waste water enters the heat exchangers at 150 F. The fresh water enters the heat exchangers at 58 F. The fresh water leaves the heat exchangers at 100 F. The flow of fresh water is 1500 gpm. The fresh water is heated from 100 F to any required temperature with live steam in the wash boxes. Our steam is metered at 200 psig.

We have been using the following formula for figuring the amount of steam saved by our heat exchanger installation.

(Gpm fresh water × 8.33 × 60 × Deg F rise in temp) ÷ (total heat of steam at 200 psig) = lb steam saved per hr

$$\frac{1500 \times 8.33 \times 60 \times 42}{1198.7} =$$

26,400 lb steam at 200 psig saved per hr by heat exchangers.

Is this formula correct?

Editor's Note:—Below are a number of recalculations of H.A.W.'s method and you will note they give answers differing slightly. One reason is that some of the boys forgot that steam pressure was specified as 200 psi *gage*, and, as Freyberg points out, that is 215 psi absolute and the difference in enthalpy is 0.9 Btu per pound.

However, in our copy of Keenan & Keyes Steam Tables, 1936 Edition, the enthalpies at saturation temperature are given as

200 psi absolute....1198.4 Btu per lb
215 psi absolute....1199.3 Btu per lb
still a difference of 0.9 Btu.

Various reproductions of the steam tables published in textbooks and handbooks over a period of years may vary slightly in this way in the 5th significant figure and may cause slight differences in answers. However, these are probably within the accepted accuracies of flowmeter measurements.

Also, note that Mr. Freyberg raises a point that originally escaped our notice. With waste water at 150 F and raw fresh water at 58 F, H.A.W. gets 100 F water leaving the heat exchanger. Pretty good, huh?

Formula Is Conservative, But Not Entirely Correct, says Freyberg

THE FORMULA is a conservative estimate of the steam saved, but it is not correct in a number of particulars.

First, and probably least important, is the fact that the enthalpy for steam at 200 psi *absolute* is 1198.7. The enthalpy of 200 psig (215 psi absolute) is 1199.6 from the Mollier chart, and for 100 psig or 115 psia is 1189.8.

Second, the formula anticipates that all the steam formerly used to heat the water gave up all its heat. Since the enthalpy of the steam used was reduced only to the enthalpy of the 150-F water delivered, only 1189.8 — 128 = 1061.8 Btu per lb of steam used was absorbed by the incoming fresh water.

Third, the steam used to heat the water is part of the 1500 gpm of fresh water delivered. Therefore the 1500 × 8.33 × 60 × 42 numerator of the formula should appear as (1500 × 8.33 × 60 — X) × 42, where X equals the pounds of steam per hour used to heat the water.

The formula then would become:

$$\frac{(1500 \text{ gpm} \times 8.33 \text{ lb/gal} \times 60 \text{ min/hr.} - X) \times 42}{\text{Enthalpy steam at 115 psia} - \text{Enthalpy water at 150 F}} =$$

lb steam saved per hr.

$$\frac{(749{,}700 - X)\ 42}{1061.8} =$$

$$\frac{31{,}487{,}400 - 42X}{1061.8} = X$$

X = 28,520 lb per hr steam saved.

The fresh water previously supplied at 58 F =

$$\frac{749{,}700 - 28{,}520}{500} = 1442.8 \text{ gpm}$$

The cost of the present 1500 gpm of fresh water as opposed to the previous 1442.8 gpm should be taken into consideration in the calculations of the savings involved in the use of the new heat exchangers. It is probable that such cost is more than offset by the additional work done by the steam no longer used for heating.

From the data given it appears that more than 1500 gpm of waste water at 150 F must be available for heating the incoming water. If equal quantities of 58-F and 150-F water are thoroughly mixed together the resulting temperature would be only 104 F. That your questioner gets 100-deg water in a heat exchanger is extraordinary. How does he accomplish this, with a counterflow type exchanger?

Pleasantville, N. Y. R. H. FREYBERG

Calculation by Evans

HEAT RECLAIMED equals the decreased heat input neglecting losses. The heat reclaimed equals 60 × 8.33 × 1500 × (100 — 58) Btu per hr. The specific heat of water equals unity.

The heat decrease by steam due to the exchanger, assuming 200-psig metered saturated steam throttled to 100 Psig and trapped in coils would equal 1198.7 — 308.8 or 889.9 Btu per lb. The heat in the condensate could be returned to the boilers. The 308.8 is the heat in the saturated liquid at 100 psig.

The pounds of steam per hour saved in a trapped 100-psig system =

$$\frac{60 \times 8.33 \times 1500 \times (100 - 58)}{889.9} =$$

35,400 lb per hr of 200-psig steam.

For open heating, using 150 F wash water, the heat decrease due to the heat exchanger would equal 1198.7 — (150 — 32) = 1080.7 Btu per lb. Enthalpy is measured above 32 F.

The amount of steam saved per hour =

$$\frac{60 \times 1500 \times 8.33 \times (100 - 58)}{1080.7} =$$

29,100 lb per hr.

It then would take more heat from the fuel to produce 200-psig steam. If you could pull an absolute pressure of 0.0887 psi in the trapped coils, you would be correct in using the total heat in 200-psig steam.

Chicago, Illinois MELVIN EVANS

He Has Overlooked Heat of Liquid, Says Porter

H.A.W. is substantially correct on his formula for steam saving, but he has overlooked the heat of liquid at the higher temperature in his calculations. Actually, to heat the water in the wash boxes, with steam condensing in the water this formula applies:

1. Lb steam required

$$= \frac{1500 \times 8.33 \times 60 \times 42}{1198.7 - 67.93}$$

= 27,850 lb per hr

and he will actually have flowing through his boxes

2. $1500 + \frac{27850}{8.26 \times 60} = 1556$ gpm of water.

If the steam is in coils then the same amount is required, but he gets 1500 gpm of wash water and 56 gpm of condensate.

Assuming this condition to be the case then to get the same amount of wash water as before the exchanger installation, he is saving, as shown, 27,850 lb of steam per hour, theoretically. Actually, if he has coils in his boxes, he is probably saving more than this because of trap leakage, and flash from trap discharge. If he is heating by direct contact in the boxes he may save less due to the carelessness of machine operators in not reducing steam supply to the boxes, enough to fully compensate for the increase in fresh water temperature, especially if he is carrying this temperature close to the boiling point.

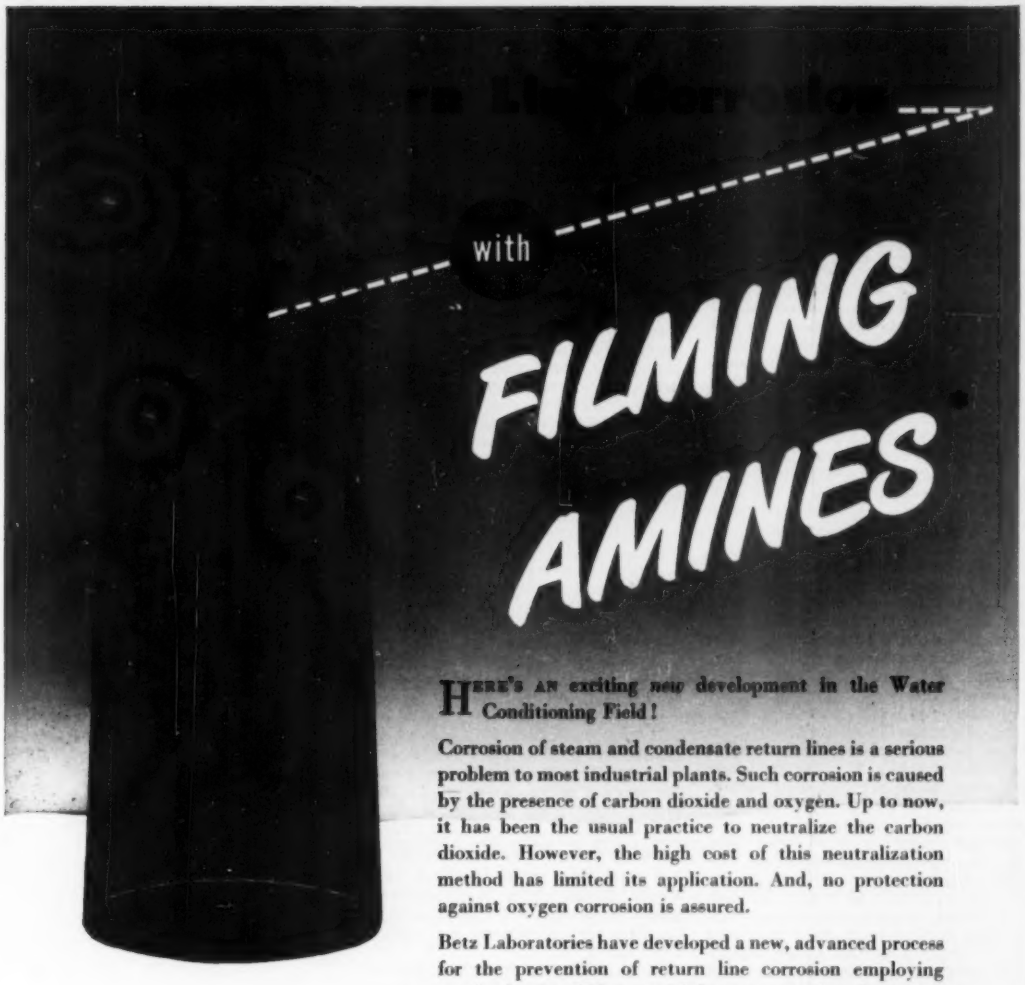
It is necessary to use the reduced value of total heat of 200-psi steam because of the fact that he was condensing it at 100 F rather than at 32 F, the value used in steam tables.

Rock Hill, S. C. J. C. PORTER

Answer No. 467

HOW CAN HE LIMIT DUPLEX PUMP SPEED?

THEY ARE in search of a device that limits the strokes per minute of duplex steam pumps, said F.L.S., August issue. They have had two pumps damaged in the past year due to high speeds. Pressure-limiting governors on the discharge end are not effective.



with

FILMING AMINES

HERE'S AN exciting *new* development in the Water Conditioning Field!

Corrosion of steam and condensate return lines is a serious problem to most industrial plants. Such corrosion is caused by the presence of carbon dioxide and oxygen. Up to now, it has been the usual practice to neutralize the carbon dioxide. However, the high cost of this neutralization method has limited its application. And, no protection against oxygen corrosion is assured.

Betz Laboratories have developed a new, advanced process for the prevention of return line corrosion employing *octadecylamine*. This material *does not* neutralize the carbon dioxide. Instead, the amine is adsorbed on the metal surfaces in a monomolecular non-wettable film which acts as a barrier between the metal and the condensate, protecting against both oxygen and carbon dioxide attack. The monomolecular film does not increase in thickness with continued treatment. Results? As high as *99 percent reduction* in corrosion rate has been achieved!

Let a Betz Field Engineer show how you can cut costs in your plant with the use of filming amines. Write today! There's no obligation, of course. W. H. & L. D. BETZ, Gillingham & Worth Sts., Philadelphia 24, Pa. In Canada: BETZ Laboratories, Limited, Montreal 1.

Send for Betz Technical Paper #120, "How Filming Amines Prevent Steam and Return Line Corrosion".

*U. S. PATENT 2,460,259

BETZ

BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT

Editor's Note:—Many answers to this question pointed out that the pump speed governor, shown in Fig. 1, on the market for many years, was widely and successfully used for this purpose. Most of them said it was the best device they knew of or had ever used to control reciprocating pump speed.

Among those giving this information were Richard Freyberg, Pleasantville, N. Y.; G. N. Andrews, Wood River, Ill.; Dean E. Wright, Woodbourne, N. Y.; A. M. Leader, Warwick, R. I.

For engineers who need such a governor, here are some details. The pump speed governor in question is designed for maintaining, automatically, a uniform speed of simplex or duplex, double- or single-acting steam pumps, and all classes of flywheel pumps, including vacuum pumps, air compressors and ice machines.

Here's how it works. Referring to Fig. 1, plunger A works horizontally, in unison with the strokes of the pump, inside the reservoir filled with light lubricating oil. The plunger is connected through yoke B, rocker C and shaft D to motion arm E which is in turn connected by a rod to some reciprocating part of the pump. Oil flows through check valves F into the plunger chamber, whence it is forced up the passage through valve G under piston H. Oil then returns by valve J, which is adjusted by key K, into the lower chamber to be repumped as before.

In case the pump or engine runs more rapidly than is desired, oil is pumped under piston H faster than it can pass through outlet J. The resultant oil pressure forces piston H upward, raising lever L with weight M, which moves a rod connected from jaw N to a balanced valve located in the steam supply line to the pump. The steam supply is throttled to reduce the pump speed to the number of strokes for which the governor is adjusted.

In case the pump runs slower than is intended, oil runs out of the chamber under piston H faster than it is pumped in, which permits weight M to move lever L down, opening the balanced valve to increase the steam supply to the pump and maintain the required speed.

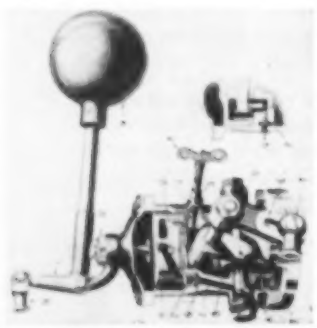


Fig. 1. Phantom view showing interior of well-known pump speed governor, operating as described under Answer No. 467

The dashpot O being filled with oil, acts as a check to prevent irregular action of main piston H. The flow of oil into and out of the dashpot is governed by adjusting screw P.

Two Ideas from Evans

THE MOST INEXPENSIVE method to limit the speed would be to run a test on the pump at constant steam pressure and varying liquid discharge pressures. Knowing the maximum rpm (or strokes per minute allowable), the liquid pressure can be dropped to a point at which the pump reaches its maximum speed. Simultaneously the steam throttle can be throttled so that at the minimum liquid discharge pressure at which the pump reaches its maximum speed the opening of the throttle valve will just maintain the maximum speed. The valve can be fastened in this position.

A more expensive method in initial cost but far cheaper in operating costs than a steam-pressure limiting device (throttling), as noted above, would be a diaphragm valve on the steam inlet, which would close tight on a low-pressure impulse as obtained by a test as noted above. This could be made to sound an alarm if the pump was located in a remote place and would be a signal for investigation or a call for another pump to be put on the line.

Chicago, Ill. MELVIN EVANS

Wright Uses the Speed Governor

I HAVE just read Question 467 where F.L.S. wants to control the speed of his duplex pumps, and I can heartily recommend the system I am using.

During 25 years with both duplex and simplex steam pumps, I have seen most everything tried to control them, homemade and manufactured. To my mind the best of all is the governor of Fig. 1.

At present, I have several pumps controlled by various pressure and vacuum valves; but every one is fitted with the governor as an overspeed control. It is regulated so that normally it has no effect on the pump. But let something fail and the pump tries to run away, and the speed governor comes into play, and while the pump will run faster than it should, it is still slow enough to avoid damage.

A long time ago, I operated a steam-driven Frick ammonia compressor that had one of these governors on it as a speed control. It did a good job in regulating the capacity of the machine. We ran it from about 30 to 75 rpm.

I hope this will do the trick for our friend, as I know of nothing better.

Woodbourne, N. Y. DEAN E. WRIGHT

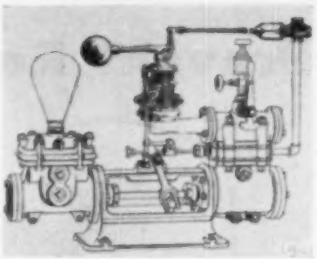


Fig. 2. How the pump speed governor is installed on a single-acting steam pump

Diaphragm Type Governor

THERE IS also another type of speed limiting or shut-off governor in addition to the one described above. It is operated by a diaphragm acting on a reverse-acting valve in the steam supply line.

In case of lost or greatly lowered discharge pressure, the spring or weight opposing the diaphragm acts to close the valve and limit the speed of the pump or shut it down entirely.

Some of the regulator manufacturers should be in a position to furnish a device of this kind.

Either of these should be effective in preventing damage from excessive speed due to loss of suction or discharge pressure.

Warwick, R. I. A. M. LEADER

Answer No. 468

WHAT IS RATE OF CONDENSATION PER SQUARE FOOT OF STEAM COIL?

WILL YOU please tell me, asked V.L.G., August issue, what is the rate of condensation per square foot of steam coil submerged in water whose temperature is 60 F? Saturated steam is supplied to the coil at 135 psig, or 150 psia and 358.4 F (from the steam tables).

Editor's Note: Obviously it is necessary here, as in so many questions, to make some assumptions. But the important thing is to do so and then indicate the *method* of solution. The questioner can then put in his own numerical values and calculate the answer for his conditions.

Here's some help for V.L.G.

Evans Uses General Formula for Heat Transmission

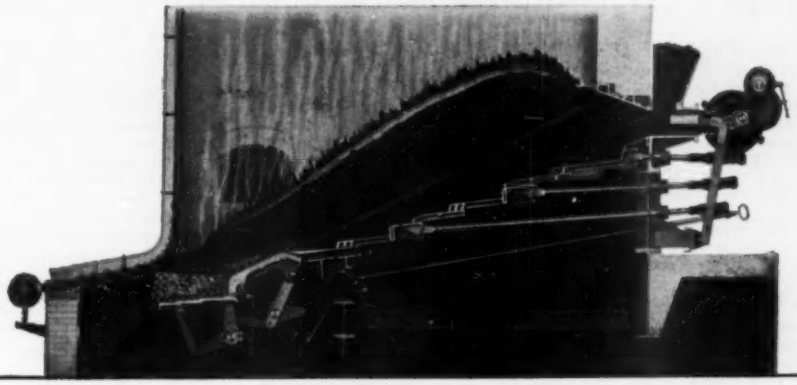
THE GENERAL FORMULA for heat transmission is applicable, although the film coefficients for condensing steam and water have a wide range of values.

$$Q \text{ in Btu per sq ft per hr} = \frac{t_1 - t_2}{\frac{1}{h_s} + \frac{1}{K_m} + \frac{L_m}{h_w}}$$

where t_1 = hot fluid temperature
t_2 = cold fluid temperature
h_s = film coefficient for steam

When you plan a power plant, remember . . .

AMERICAN ENGINEERING COMPANY TAYLOR STOKERS ELIMINATE STACK NUISANCE



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h_w = film coefficient for water
L_m = thickness of metal
K_m = 26.2 for steel
$h_o = 20\ (\Delta_t + D)^{0.25}$
where $\Delta_t = t_1 - t_2$
D = diameter of pipe in inches

$$h_o = 20 \left(\frac{358.4 - 60}{1}\right)^{0.25} =$$

83 Btu per hr per deg F

Thickness of metal L_m for 1-in.-Sched. 40 pipe = 0.133 in. (from pipe tables)

$$Q = \frac{358.4 - 60}{\frac{1}{83} + \frac{0.133}{26.2} + \frac{1}{0.35}} =$$

103.8 Btu per hr per sq ft.

The film coefficient for the water predominates so that the steam resistance and metal resistance can be omitted without serious error.

Using 150-psia steam, whose latent heat is 863.1 Btu per lb, the lb steam hr per sq ft of 1 in. coil is:

$$\frac{103.8}{863.1} = 0.12 \text{ lb per hr per sq ft}$$

Chicago, Ill. MELVIN EVANS

Here's a Different Answer

CONDENSATION RATE per sq ft per hr = 2.7 × sq ft area × temperature difference ÷ latent heat of steam. 2.7 × 1 × (358.5 — 60) ÷ 863 = 0.9335 lb steam per hr.

Cincinnati, Ohio J.D.W.

Porter Shows How to Get Approximation

V. L. G. did not give enough information for a definite answer to his question but with certain assumptions we can give him an approximation of what he can expect. Assume that he is using steel pipe coil, and that the water is heated from 60 F to 120 F. This gives an average temperature of 90 F, or a difference between steam temperature and water temperature of 358.4 — 90 = 268.4 F. Under these conditions, and with clean new pipe, approximately 140,000 Btu per hr will be conducted per square foot of external pipe surfaces.

The amount of steam condensed per square foot will be:

140,000 ÷ (1193.5 — 120 + 32)
= 126.7 lb per hr per sq ft

If the water temperature is maintained at 60 F, giving a temperature difference of

358.4 — 60 = 298.4

then the heat conducted will be 200,000 Btu per hr per sq ft and the steam condensed will be

200,000 ÷ (1193.5 — 60 + 32)
= 171.6 lb per sq ft per hr

These figures are arrived at from standard heat conduction charts rather than being accurately worked out because of the lack of accurate essential information.

Rock Hill, S. C. J. C. PORTER

LETTERS TO THE EDITORS

(Continued from page 53)

or actually on a job, or in the repair shop.

Our second filing system: identifying the location of the apparatus, is built very much along similar lines, still using the visible card system[1]. Only the code is different and very special to our particular conditions. I will only give, very briefly, its underlying principles so as to serve as a guide, but each particular case should be given its own treatment.

Our code is based on the decimal classification system. The whole of the power plant has been divided into ten classes numbered 0 to 9. Each class is then divided into ten subclasses, and so on indefinitely.

For instance: No. 3 identifies the buildings; No. 4 the mechanical equipment; No. 5 the electrical equipment; etc. . . .

Class 4, for example, is subdivided into:

40 water supply
41 coal supply
42 main production equipment
43 ash handling
and so on . . .

This breaks down to something like this:

400.10-1 Traveling screen No. 1 for condensers circulating water.
400.11 Chlorinating pump.
401.14 Lime mixing pump for make-up water softening.
433.1-1 Vacuum pump No. 1 on ash filtering tank.
and so on . . .

In this case it is the equipment that is permanent, and the motor that can be changed; whereas in the first file the motor is permanent, but its location can change.

This last code has been in use for a number of years for the filing of all our documents: correspondence, orders, specifications, drawings, etc.; and now for the above problem.

I don't pretend that our system is any better than numerous other ones. In our specific case it does the trick and does it well. I'll be happy should Mr. Shortridge find any useful idea in my contribution.

I also wish to state that this article is not intended as publicity for Remington-Rand. I used the name Kardex because I imagine it is the best known in the States; in fact, our filing equipment has *not* been supplied by Remington.

Before closing this too long letter, I wish to express to you the immense pleasure I derive every month from reading your very interesting and lively paper.

P. VANHERK
rue Alfred Magis 5
Liege, Belgium

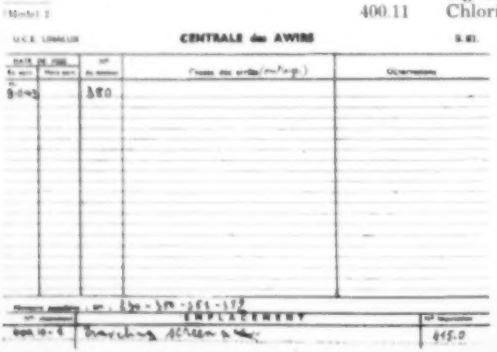

Fig. 2. Card for identifying location of equipment (front and back the same)

A SUGGESTION FROM RADIO TECHNIQUE

I WOULD LIKE to offer my suggestion for a method of identifying motors that will answer the requirements of S. R. Shortridge in your July 1950 issue.

As long as he has an index with all the motor information in it, all he needs is to be able to distinguish the plant index number of the motor. This can very easily be done by using the same RMA color code radio manufacturers use on resistors, except that every dot will stand for a significant figure. These dots can be as large as desired, can be read from left to right or from top to bottom, depending upon the motor mounting and its size.

They can be painted as stripes as they do on resistors. The color code is as follows:

Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

For example, if a motor had a number 1247, you would paint a brown, red, yellow and violet stripe in that order on the motor.

I hope the above is of some use to Mr. Shortridge.

ABRAHAM PINKUS
Pinkus Electric Company
Cambridge 38, Mass.

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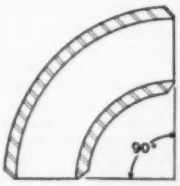
Accurate bevels aid aligning and welding. Standard straight bevel for thickness (T) 3/16 to 3/4 inch inclusive. Standard U-bevel for thickness (T) greater than 3/4 inch.



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Lightweight Turbine Generator Rotors

Here, is presented an entirely new idea for the design and construction of high-speed electric generators. It involves a new type of rotor construction with specially shaped conductors made of aluminum or magnesium alloy. These materials offer high strength combined with light weight. Everyone interested in or concerned with the design of modern electric generators should give thought to Mr. de Konings proposed design since it is only by the adoption of such radically new ideas that we can hope to improve our already highly developed machines

By **THEODORE DE KONING,**
Consulting Engineer, Philadelphia, Pa.

ONE OF THE GREATEST deterrents to continued progress in any art is a state of satisfaction with things as they are. This is true in the field of electrical engineering as it is anywhere else, particularly in the older branches of the field not having the glamour of some of the newer branches involving electronics.

The field of electric generator design offers a good example. If we look back over the history of the electric generator we can well be proud of our achievements in this branch of the electrical art. We have come a long way from the old Jumbo dynamos of Edison's Pearl Street Station to the modern 100,000 kw, 3600 rpm hydrogen-cooled generators of today. Offhand the modern streamlined electric generator seems about as perfect a machine of its type, considering the materials of which it is made, as we could wish for. It is highly efficient and its reliability is such that it can operate for years without stopping. What more could anyone ask?

It is this last question that we must ask ourselves. Are we completely satisfied with electric generators as they are? Are we certain that they cannot be improved? Of course, there is always room for further refinement but are we sure that present type generators cannot undergo much greater improvement by an entirely new approach? We must remember that the rotor is the limiting factor in turbine generator design.

It is with these thoughts in mind that the author presents the design described in a paper delivered at the winter meeting of the American Institute of Electrical Engineers in New York last January. The design involves a new type rotor which lifts the present limitations imposed by heating and centrifugal force upon non-salient pole rotors of large electrical machines.

This rotor involves a number of novel features both as regards design and the materials used. The higher the speed of a device, the lighter it must be to fulfill its functions properly, so in this new rotor, the need for high strength and light weight is taken into account by the extensive use of lightweight aluminum and magnesium alloys.

The principle of construction can be seen from the diagram in Fig. 1 which compares the new type of construction with the method now in use. The conductors are specially shaped extruded elements, covered with a laquer-reinforced oxide coating, and laid in slots from the rotor periphery, one at a time, the outer ones first. These are spread apart until they lock with the corresponding slot walls, which are covered with a thin sheet of insulation. After this, the other conductors are laid in and spread apart, this going on until the last inner conductor is laid in.

Compare this construction with that in a rotor of present design. The weak tooth root which holds the centrifugally heavy trapezoidal tooth, the field coil, and the wedge, is replaced by a tooth shape ideal from a mechanical and also a magnetic point of view.

The windings are self supporting. The former poor filling factor of the slots because of the insulation, wedge and air duct clearances needed now is very good indeed. At the same time the drop shaped slot is larger in size and the magnetic leakage less.

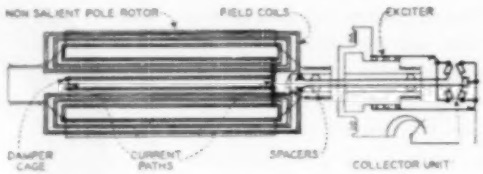

Fig. 2. Main circuits of the lightweight rotor. Conductor ends are welded together to form field coils

From a heat flow point of view the segmental conductor arrangement is considerably better. The conductors are practically the only source of heat losses in the rotor. The temperature drop from the farthest conductor tip to the rotor periphery is only a few degrees C. The temperature differences between adjacent conductors, and between conductors and tooth surfaces are negligible.

The use of extruded conductors is proposed because extrusion is a favored process for magnesium. The conductors have enough strength to relieve the rotor tips of their load and that of the wedges. Magnesium conductors need three times the cross section of copper conductors, everything else being equal. With a terminal voltage of 80 volts instead of the customary 250 v, the number of turns per slot is reduced to one-third.

In the present rotors about 40 per cent of the slot space can be used for conductive material, 40 per cent is needed for the insulation, and 20 per cent for the wedge and bottom cooling spaces. With lightweight rotors the slot space is about 20 per cent larger. About 85 per cent of

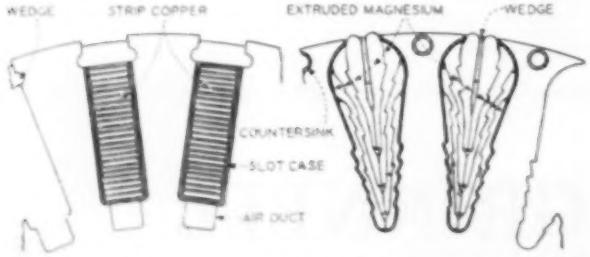

Fig. 1. Comparison of a conventional rotor design with the new de Koning design. The conventional design is shown at the left. At the right is a section of the proposed lightweight construction

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the space can be used for conductive material. The mean-turn length of the coils is 4 to 10 per cent shorter, the full-load resistance due to lower temperature 8 per cent less.

For a 2-pole 60-cycle 50,000-kva turbine generator the temperature drop in the rotor insulation is about 24 degrees centigrade, in the rotor teeth a further 24 degrees centigrade, or a total of 48 degrees centigrade. Assume that with lightweight rotors one-fourth of the periphery is taken up by the middle conductors, which remove two-thirds of the heat losses leaving one-third to the teeth. The equivalent total temperature drop is now 8 degrees centigrade.

Figure 2 shows a wiring sketch of a lightweight rotor. The conductor ends are welded together to form the field coils. Magnesium containing 1½ per cent manganese is well known for its excellent weldability. The strength of the weld, as is, is about two-thirds of that of the extruded shapes. The wedges provide useful high-pressure contacts.

The pressure exerted on each side of a wedge is equal and can easily be 40 times the pulling pressure. Differences in the width of slots and shapes has no influence upon the pressure exerted. The pressure can be varied over the rotor length. The weight of the wedge is small so the centrifugal force is of no influence. Local projections can be used where a conductor must form an electric contact with the slot wall or another conductor.

The following advantages may be expected with this scheme:

1. About three-fourths of the weight, one-half of the inertia, and twice the maximum peripheral speed of the equivalent present type of rotors.

2. About one-sixth of the maximum temperature drop, seven-eighths the field coil wattage, shorter mean-turn length, lower temperature, assuming that the same ampereturns are needed.

3. The well-developed tooth tips and the improved tooth form decrease the magnetic leakage, as well as the ampereturns and the winding space needed.

4. The segmental wedges lock the rotor solidly together, squeeze out the air layers, eliminate bending forces on the rotor tooth feet, and can smooth the flux distribution on the poles.

5. The damper cage and the field windings can be simplified by the use of elastic high-pressure spot contacts.

This rotor then, instead of being an electrical construction poorly adapted to the magnetic and mechanical requirements, has become foremost a mechanical construction well adapted to the electrical and magnetic needs. Detailed calculations indicate no particular difficulty in manufacturing such a machine.

Monobed—Something New in Ion Exchange for Water Treatment

NEW DEVELOPMENT in the use of intimate mixtures of anion and cation exchangers in a single bed of resins was announced last June. It is designed to completely deionize water in one pass through one unit. The use of ion exchange resins for water treatment, either alone or in combination with other methods of treatment, has been increasing rapidly during the past few years. Until recently it was necessary to use anion and cation exchangers in separate beds, (that is, in separate containers) but now the development of new types of ion exchange resins permits various types to be mixed, each type performing its functions separately and yet of such a nature that it can be regenerated separately and then re-mixed in the container.

The new process, whose various forms are termed Amberlite Monobeds, was described by their producer, The Resinous Products Division of Rohm & Haas Company, as offering to the water conditioning industries a number of advantages over the two-bed system. It is claimed that the new process requires simpler and potentially less costly equipment; that it is capable of more complete deionization than the two-bed system; that it is easier to operate, reduces rinse requirements and costs less to regenerate; has sharp break-through; and that it permits constant maintenance of neutral pH during ionization, (the latter, it is stated, not too important in boiler water conditioning) and provides for controlled quality of effluent.

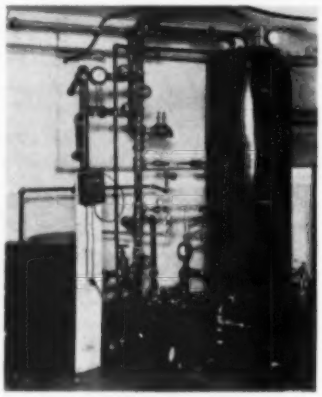


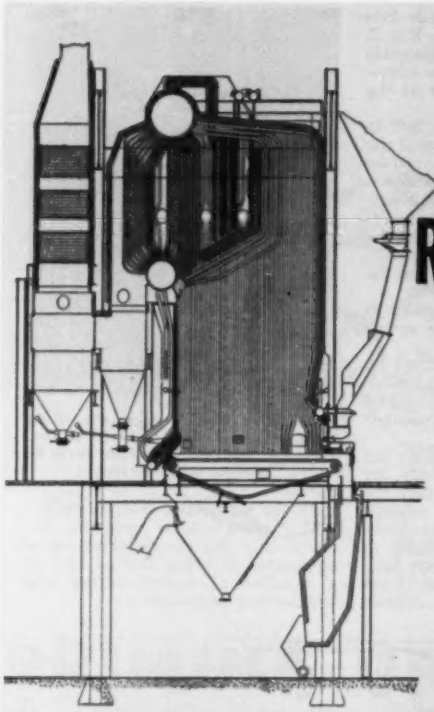
Fig. 1. A typical Monobed ion exchange resin column, as produced by one manufacturer of water treating equipment

Fig. 2. After backwashing at the proper rate, the two types of resins, formerly thoroughly mixed, will settle out as shown here

This new Monobed process is best demonstrated by the use of the glass columns of relatively small size, as shown in Figs. 2 and 4. These are essentially laboratory equipment, but permit the entire process to be observed. A number of manufacturers of water treating equipment are now developing commercial types of tanks and accessories somewhat along the lines shown in Fig. 1. There are, of course a great many uses for small quantities of very pure water in laboratories and processes, but there are also many applications of ion exchange treatment for demineralizing, silica removal and the like in large-scale industrial and boiler feedwater conditioning and it is expected that this field, at least for the present, will be the most important one for the new process. As to capacity, Monobed equipment has already been built or is under construction for capacities

Table showing reactions occurring in Monobed ion exchange system.

Type of Reaction	Reactions on Cation Exchanger	Reactions on Anion Exchanger
Splitting of salts	$R_x^-H^+ + Na^+Cl^- \rightleftharpoons \boxed{H^+Cl^-} + R_x^-Na^+$	$R_x^+OH^- + Na^+Cl^- \rightleftharpoons \boxed{Na^+OH^-} + R_x^+Cl^-$
Neutralization	$R_x^-H^+ + \boxed{Na^+OH^-} \rightarrow R_x^-Na^+ + H_2O$	$R_x^+OH^- + \boxed{H^+Cl^-} \rightarrow R_x^+Cl^- + H_2O$

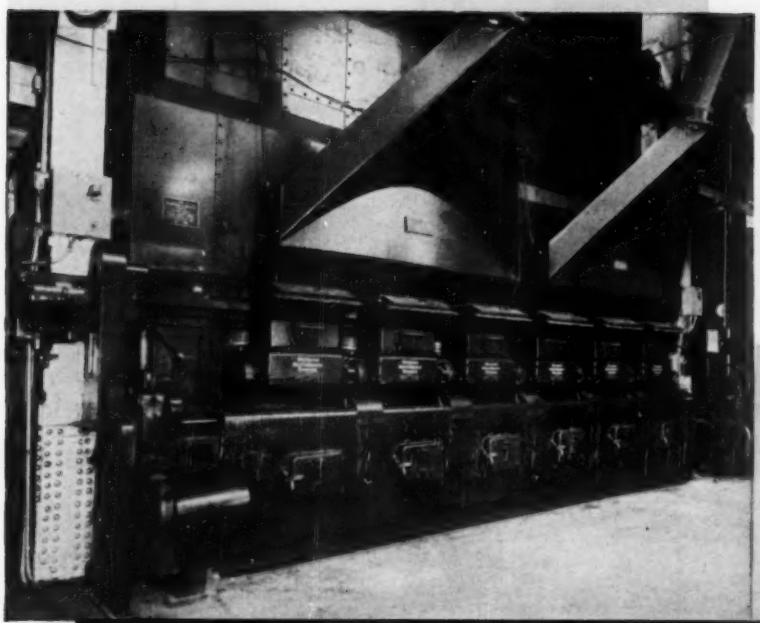


RotoGrates Bought Twice For Erie

General Electric Company twice selected **Detroit RotoGrate Stokers** for their Erie, Pennsylvania, plant. First Unit —150,000 pounds. Second Unit—175,000 pounds. Both modern installations are with Babcock and Wilcox Steam Generators.

Detroit RotoGrate is an improved spreader stoker in which grates move slowly forward, automatically discharging ash at the front. Economically burns all grades of Bituminous Coal or Lignite. Higher burning rates produce more capacity per foot of furnace width, keeping down investments in both steam generating equipment and building. Thermal efficiency is exceptionally high . . . either with steady or fluctuating loads.

It will pay you to investigate the RotoGrate.



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DETROIT SINCE 1898 STOKERS

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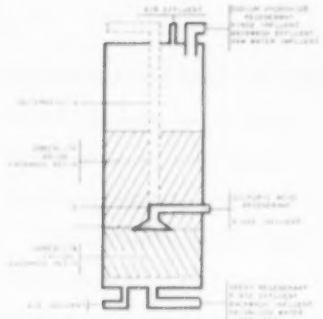

Fig. 3. The actual equipment must be designed, as shown here schematically, so that the distributor C will be located at the boundary between the two resin zones

up to 150,000 gal of deionized water per day, equivalent to approximately 52,000 lb per hr.

Here's how the process works. The anion and cation exchange resins are intimately mixed in a container and the water to be treated is passed down through them. In conventional deionizing systems, the cations of the salts contained in the water are absorbed on a cation exchange resin by exchange of the cations in solution for the hydrogen ions on the exchange positions of the resin. The acidic effluent from the cation exchange bed is then passed into an anion exchange unit where the anions of the salt are exchanged for hydroxyl or adsorbed as acids. The result is the production of mineral-free water.

In the Monobed process, with the two types of ion exchange resins mixed, the bed may be regarded as a multiple deionization unit consisting of countless numbers of cation and anion exchange columns arranged alternately in a series. Since hydrogen ions produced during the cation exchange process are almost immediately removed from the scene of reaction by absorption or neutralization on the anion exchange resin and since any hydroxyl ions produced on the anion exchange resin immediately react with hydrogen ions from the cation exchange resin, even unfavorable exchange equilibrium may be driven to completion in a Monobed unit. The results are shown in the table.

After the resins are exhausted—that is, have picked up all the ions they can from the water—the whole system is regenerated by the very simple method given below. The equipment itself must be arranged schematically as shown in Fig. 3. After suitable tests of the water leaving the unit have shown that the resins are exhausted, they are regenerated as follows:

a. The exhausted bed is first backwashed briefly at a rate such that the ion exchanger collects in a separate layer in the column above the denser cation exchange resin, and they are allowed to settle into place as two distinct zones, Fig. 2.

b. Alkaline solution to regenerate the anion exchange resin is introduced through a distributor at the side or top of the column.

c. Most of the free base left in the bed from the regeneration of the anion exchanger is next removed by rinsing the bed briefly with water.

d. Next, dilute sulfuric acid is now passed through the cation exchange zone, but not through the anion exchange zone, from distributor "C", located at the boundary between the two resin zones.

e. The cation exchange zone is now rinsed briefly to remove excess sulfuric acid.

f. The resins are now remixed by admitting an air jet at the bottom of the shell, as shown in Fig. 4, and the bed is now ready for another exhaustion step.

A form of the Amberlite resin has been worked out, particularly for disposable cartridges in which the resin is self-indicating. The original color of the resins is deep blue-black, showing a yellow band of color at the top of the resin bed; as exhaustion proceeds, this band extends farther down the column until the whole bed is light yellow.

Fig. 4. After complete regeneration of the two resins and final rinsing, a jet of compressed air mixes the resins again ready for another exhaustion step

The manufacturer produces the resins only and the development of equipment is being carried out by a number of manufacturers and engineering organizations.

"Come on, follow me—we gotta get this thing cleaned out!"

PRIMING OR FOAMING?

Carryover is a tough problem that you can't argue, or guess, out of existence. It can cause serious mechanical, operating and processing difficulties, ranging from damage to process materials to deposits on high pressure turbine blades. To know the cure, you *must* first know the cause. The chief causes of carryover are priming and foaming.

Priming, the *mechanical* entrainment of boiler water in steam, is caused by "belching" or surging. Its correction usually involves *mechanical* considerations, such as operating and design modification.

Foaming, the entrainment of boiler water in steam, is caused by build-up of foam. It results from high alkalinity, high dissolved and suspended solids, oil contamination, etc. Correction of foaming usually involves *chemical* considerations, such as proper control, anti-foam treatments, etc.

The Drew System of Water Treatment eliminates guesswork! It starts with proper diagnosis. It includes recommendations for corrective treatment and other preventive measures, such as modification of operating cycles and redesign of equipment, if required. It is specialized service applied to your individual boiler problem.

Don't gamble with guesses! Consult the Drew Engineer or write for further information on carryover and other water problems.

POWER DREW CHEMICALS

Power Chemicals Division

E. F. DREW & CO., INC.

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Nationwide service in Boiler Water and Cooling Water Conditioning

DREW PRODUCTS

AGAIN...IN 1950

DIAMOND DOMINATES IN SOOT BLOWERS

NORTH

- *Central Illinois Electric & Gas Co. — *Rockford*
- *Central Illinois Public Service Co. — *Hutsonville*
- Cincinnati Gas & Electric Co. — *Clermont*
- Illinois Power Co. — *Hennepin*
- Indiana & Michigan Electric Co. — *Tanners Creek*
- *Indianapolis Power & Light Co. — *White River*
- *Northern States Power Co. — *Sioux Falls*
- *Ohio Edison Co. — *Burger*
- *Public Service Company of Indiana — *Edwardsport*

SOUTH

- *Alabama Power Co. — *Gorgas*
- *Appalachian Electric Power Co. — *Philip Sporn*
- *Carolina Power and Light Co. — *Goldsboro*
- *Carolina Power and Light Co. — *Lumberton*
- *Consolidated Gas, Electric Light and Power Co. — *Gould Street*
- Georgia Power Co. — *Brunswick*
- *Georgia Power Co. — *Plant Yates*
- *Louisville Gas and Electric Co. — *Paddy's Run*
- *The Ohio Power Co. — *Philip Sporn*
- Tennessee Valley Authority — *New Johnsonville*
- Tennessee Valley Authority — *Bridgeport*
- *Virginia Electric and Power Co. — *Possum Point*

EAST

- Central Hudson Gas and Electric Co. — *Danskammer*
- Central Maine Power Co. — *Mason*
- Consolidated Edison Co. — *Astoria*
- *Jersey Central Power & Light Co. — *South Amboy*
- Maine Public Service Co. — *Caribou*
- *Niagara Mohawk Power Corp. — *Oswego*
- *Potomac Electric Power Co. — *Benning*
- *Public Service Electric and Gas Co. — *Sewaren*
- *Western Massachusetts Electric Company — *West Springfield*

WEST

- *Interstate Power Co. — *Dubuque*
- *Iowa Power and Light Co. — *Des Moines*
- *Kansas Power and Light Co. — *Tecumseh*
- *Kansas Power and Light Co. — *Lawrence*
- *Public Service Company of Colorado — *Arapahoe*
- *San Diego Gas and Electric Co. — *Silver Gate*
- Southern Colorado Power Co. — *Rocky Ford*
- Union Electric Company of Missouri — *Meramec*

*REPEAT CONTRACTS FOR SAME STATION

In 1950, as in '49, '48, '47, etc., leading public utilities are indicating nationwide preference for Diamond Soot Blowers. Conclusive evidence is in this list of central station contracts (complete steam generators only) above 600 psi for the first eight months of 1950. TODAY . . . as yesterday . . . Diamond Dominates in soot blowers.

DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO
Diamond Specialty Limited — Windsor, Ontario

BETTER BOILER CLEANING AT LOWER COST
Is the Reason Why
DIAMOND DOMINATES

Good Maintenance Prolongs Diesel Life

Twenty-two-year old Diesel engines in Marion, Kansas, still dependable as a result of good preventive maintenance and annual overhaul of engines. Both plant and output grow

By HENRY J. BARBOUR,
Fairbanks, Morse & Company

IT IS AN OBVIOUS fact that the heavy duty diesel, with its replaceable cylinder liners and bearings, can continue indefinitely to produce its rated power. Even the factor of obsolescence has been in large measure eliminated by some manufacturers through careful design of new models to permit modernization of old engines in the field. The fact, however, that impresses the observer who visits many diesel power plants throughout the country is that so many diesels continue dependable and efficient service over a long period of years without replacement of cylinder liners and bearings.

A case in point is the Marion, Kansas, municipal power plant where a 560-hp Fairbanks-Morse diesel has been in service for more than 22 years. This unit is in operation daily and within the past year has run as much as 30 days without shutdown. The engine still has its original liners and only one bearing has been rebabbitted.

A second unit in the plant is a 1050-hp Model 33D Fairbanks-Morse diesel which was installed in 1939. Though this 11 year old engine runs about 4000 hours a year, all the original cylinder liners and bearings are still in use. Newest engine in the plant is a 1200-hp Model 33F F-M diesel which went into service in 1948. There have been no liner of bearing changes on this unit.

Merely to keep diesels running over a long span of years without major part replacements is worthy of note but it is equally important to check on the efficiency and economy of the veteran prime movers. Total maintenance costs for this three-engine plant average $280 a year of less than 10 cents per horsepower per year.

Maintenance of an efficient load in this agricultural community of some 2000 population has been a difficult problem. In spite of the load factor which often drops below 50 per cent, the plant maintains an average production of 11 kw hr per gal of fuel consumed. With load factor at 75 per cent, the plant average is 12.5 kw hr per gal. Lubricating economy has been excellent with a plant average in 1949 of 4837 hp hr for each gal of lubricating oil consumed.

Marion was among the pioneers in the use of oil burning engines. The first units put into service back in 1929 were two solid injection semi-diesels rated at 75 and 100 hp. Two years later the plant added two Busch air-injection diesels rated at 120 hp and 165 hp. At various times engines were taken out and new ones installed. At present the plant has a capacity of 2811 hps.

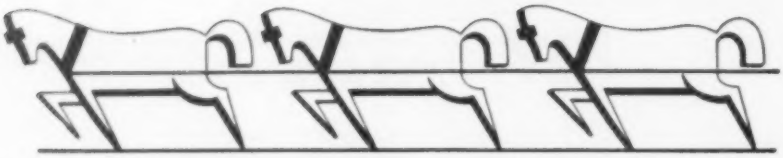
Marion's long running diesels have been consistently profitable. The old 560-hp engine, for example, led the plant to such substantial earnings that the city was able to pay off the total cost of the unit in just three years. There was enough additional profit to pay off $65,000 in water bonds. Profits have been maintained even in the present era of high operating costs. In 1949, revenues of the electric department were $76,825.59 and total expenditures including costs of generation, distribution and administration totaled $49,748.67 leaving a net profit of $27,076.92.

The operating record of Marion's diesels would not have been possible without heavy duty engines, without good protective accessory equipment and without sound operating procedures. All the engines are fully pressure lubricated and have oil-cooled pistons. Lube for the two big engines is circulated by built-in engine-driven pumps with motor-driven auxiliary pumps to circulate the oil to the bearings and and pistons in starting and shutting down the engines. The 560-hp unit utilizes a motor-driven pump for regular lube circulation. Included in the lube-pressure system of each engine is a shell-and-tube oil cooler and a bag-type filter. Each unit also is equipped with a multi-element lube filter with cellulose filtration cartridges. Oil is drawn from the crankcase by a motor-driven pump, heated, filtered and returned to the crankcase. Wiper-ring oil is put through the filter and discharged to the crankcase. Cylinders are supplied by separate mechanical lubricators.

Soft cooling water is circulated by two motor-driven centrifugal pumps

Fig. 1. The three diesel generating units at the Marion, Kansas, plant. Left to right: the 1200-hp unit installed in 1948; the 1050-hp unit installed in 1939 and the 560-hp machine installed in 1928

HARNESS WASTE HORSEPOWER WITH

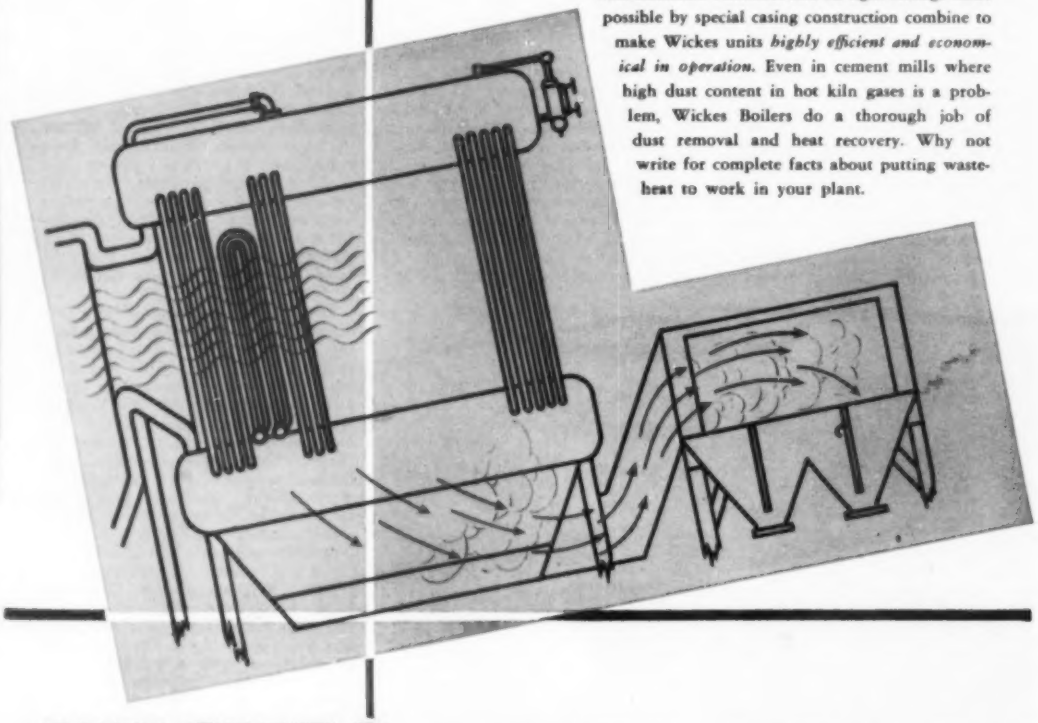


WICKES WASTE-HEAT BOILERS

CONVERT WASTE-HEAT into PROFITABLE POWER

Waste heat, once discharged from manufacturing equipment as a loss, has been made to realize a high economic return through the installation of Wickes Waste-Heat Boilers. In actual cases, the reduction in the costs of manufactured products has *paid for the waste-heat installation* within 2-3 years time, and in some industries, heat recovery is sufficient to produce all steam and power required.

Wickes Boilers are correctly designed and built to effect maximum heat recovery from all types of waste gases. High gas velocity, long gas travel with minimum resistance and air-tight settings made possible by special casing construction combine to make Wickes units *highly efficient and economical in operation*. Even in cement mills where high dust content in hot kiln gases is a problem, Wickes Boilers do a thorough job of dust removal and heat recovery. Why not write for complete facts about putting waste-heat to work in your plant.



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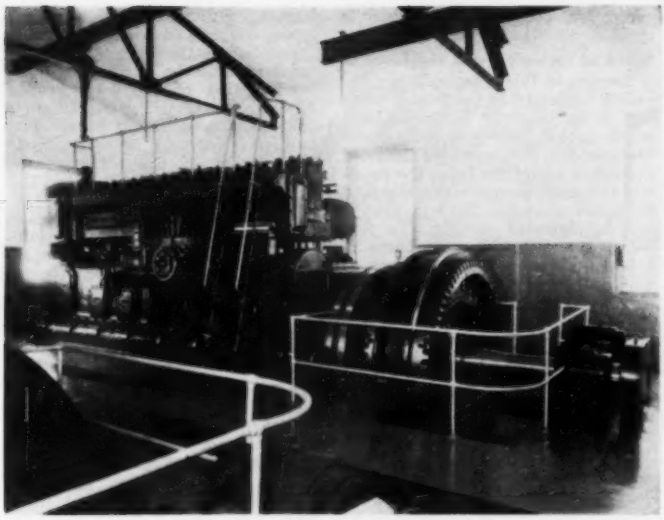


Fig. 2. This shows the 1200-hp diesel driving the 840-kw, Fairbanks, Morse alternator with its 15 kw exciter driven by Link-Belt chain drive.

from a hot well through the engine jackets, through two heat exchangers and back to the well. One pump can handle the plant easily and the other serves as a standby. One exchanger is adequate for the plant's needs through the winter months but both exchangers are used during the summer. City water is used for make-up in the closed cooling system and chemicals are added to soften the water. In emergency it is possible to run city water directly through the engine jackets at 60 to 75 lb main pressure. Another pair of motor-driven centrifugal pumps puts water through the exchangers and over an atmospheric-type cooling tower. Hand-operated valves are arranged so that either the tower or the exchangers can be by-passed as necessary to maintain jacket water temperature at the desired level.

The 34 to 36 gravity fuel oil can be delivered by either tank car or truck and is unloaded into three 1200-gal horizontal tanks above ground by a motor-driven gear pump. The fuel flows from storage through a meter to day tanks in concrete underground chambers. The tanks are so arranged that some fuel will flow from storage to the day tanks by gravity so that the day tanks cannot run dry, but a motor-driven pump must be used to fill the day tanks completely. Engine-driven supply pumps draw oil from the day tanks and supply it through duplex filters to the injection systems.

Scavenging air for these pump-scavenging two-cycle diesels is cleaned by multi-element impingement-type filters in separate concrete chambers outside the plant. Exhaust gases of the big engines vent through vertical snubbers while the smaller engine exhaust passes through an expansion pit and up a stack.

For each engine there is a gauge and alarm panel with alarms on lube pressure and jacket water pressure. There is an exhaust pyrometer on each board. All the engines drive alternators generating 3-phase, 60-cycle, 2400-v current. The alternators are rated at 840 kw, 731 kw and 375 kw. All three have 15 kw chain-driven exciters.

The true veteran of the Marion plant is Superintendent James Blackim who was on hand to install the first of the present diesels 22 years ago and has directed operations through the long decades of flawless service. Mr. Blackim long ago set up a detailed maintenance schedule and has insisted that it be followed scrupulously. Undoubtedly this careful preventive maintenance program culminating in an annual overhaul for each engine deserves a share of the credit for the absence of major repairs.

It is common practice to write off diesel engines in 20 years, at least for bookkeeping purposes. The Marion plant is demonstrating not only that good diesels never die but that they can continue for more than 20 years to produce power at a profit.

MARION, KANSAS
Principal Equipment Listing

Engines: One 560-hp Model 33, Type M Fairbanks-Morse diesel; one 1050-hp Model 33D Fairbanks-Morse diesel; one 1200-hp Model 33F Fairbanks-Morse diesel
Alternators: Three 3-phase, 60-cycle, 2400-volt alternators rated at 375 kw, 731 kw and 840 kw Fairbanks-Morse Co.
Governors: Woodward Governor Co.
Fuel filters: Wm. W. Nugent & Co., Inc., and Purolator Products, Inc.
Fuel meter: Badger
Lube oil: Nonpareil heavy duty diesel oil heavy. Standard Oil Co. of Indiana. Industrial diesel HD engine oil SAE 30. Phillips Petroleum Co.
Lube oil filters: Midwest Filter & Mfg. Co.
Cylinder lubricators: Madison-Kipp Corp.
Lube oil coolers: Schutte & Koerting; Ross Heater & Mfg. Co., Inc.
Auxiliary lube pumps: Geo. D. Roper Corp.
Cooling water pumps: Fairbanks, Morse & Co.
Heat exchangers: Ross Heater & Mfg. Co., Inc.
Exhaust snubbers: Burgess-Manning Co.
Air filters: American Air Filter Co., Inc. Midwest
Alarm panels: Fairbanks, Morse & Co.
Pyrometers: Alnor, Illinois Testing Labs, Inc.; Brown Instrument Co.
Switchboard: Independent Electric Mach. Co.
Voltage regulator: Allis-Chalmers Mfg. Co.
Synchronizer panel: Borr-Thorp Electric Co.
Totalizing kwh. meter: Westinghouse Electric & Mfg. Co.
Watt-hour demand meter: Westinghouse Electric & Mfg. Co.
Chain drive on exciter: Link Belt Co.

THE PENETRON

(Continued from page 71)

covers about 1 sq. in. Any pipe from 1 in. to 12½ in. diameter can be checked in this manner. The effect of small pits, holes, flaws or cracks is lost in the "averaging" of the material thickness; hence this type of defect cannot be traced with the Penetron.

In a pipe filled with water, the water also absorbs some of the rays. Therefore, the pipe must be empty before starting the survey. Incidentally, if a vertical pipe is partly filled with water, the meter reading quickly changes when passing the water level, hence measures the level.

The Standard Head

The principle used with this head, Fig. 2, is that of measuring the back scattered rays. The whole thickness of pipe material exposed to the bundle of gamma rays contributes to the "back scattering." The source of radium and the detector are built together in one holder. Between the radium and the detector is a conical metal shield so that no direct rays from the radium can reach the detector. Only the back-scattered rays can reach it. The thicker the material, the more the back-scattered rays.

With this standard head, it is possible to measure the wall thicknesses of pipes of any diameter, from 3 in. up, and also the thickness of plates. It is possible to measure wall thicknesses of insulated pipes without removing the insulation, providing it is not too thick. About 1½ to 2 in. is the maximum for the usual heat insulation. A standard

reading is established by using a piece of stock pipe material covered with the service insulation.

Internal Inspection of Pipes*

The wall thicknesses of pipes of 3 in. or more inside diameter can be measured internally by means of the standard head. A special holder with extension rods has been provided. Determination of the thickness of boiler tubes from inside the drums is possible so far as the bends in these tubes allow the standard head to be moved in.

When the tubes are closely spaced, the proximity of the neighboring tubes increases the readings with the standard head. If one of the tubes has been removed, correction for the back-scattering effect of the neighboring tubes is made by placing the standard head in the space previously occupied by the tube and noting and applying the reading as a correction. Of course, baffles, anchors, and masonry work affect the readings taken internally and their effect is more difficult to eliminate that that of neighboring tubes.

When no tube is removed, the correction for the proximity effect of neighboring tubes can easily be established as follows. A sufficient number of 2-ft lengths of tube is cut and placed on a wooden platform in the same pattern as the tubes in the boiler. Then the reading of the standard head is taken internally in the center tube of the pattern of samples. Then the surrounding tubes are removed and again a reading is taken. The difference between the two readings is the correction sought for the proximity effect.

Scale Effect

The readings with the Penetron are proportional to the density and thickness of the material. A certain amount of scale, slag, paint, or dirt will affect the readings very little because the density of this material is much less than that of steel and the thickness is usually limited. High density scale of oxidized metal may influence the readings considerably. It is therefore advisable to study each case individually.

Accuracy

The Penetron can be used for material thickness up to $\frac{3}{4}$ in. steel. The accuracy is about 2 per cent plus or minus for the tangential head. The accuracy obtained with the standard head is about 3 per cent plus or minus. This accuracy is reduced when the proximity effect is present, even when the proximity correction, previously described, is applied.

Speed of Surveying with the Penetron

Twenty to thirty seconds are required to establish the initial reading. If the operator holds the head in its proper geometric relation to the tube and slowly moves the head around or along the tube, the reading will only change when the wall thickness changes. Such a change can be detected readily. To find the new wall thickness in terms of actual dimension it is necessary to hold the head for a while at the new spot until the meter has obtained its new balance. It is possible to cover a path approximately 4 to 6 fpm when the wall thickness is fairly uniform. The survey of superheater tubes of a boiler can be made ordinarily within a few hours.

The Lifetime of the Geiger Counters

The use of the heads inside the cramped quarters of a boiler is not very favorable for long life of the Geiger counters. Mechanical impact or other abuses is quite likely. From experience, it appears that only 40-60 hours of service can be expected for tube survey in boilers. This is a rather short lifetime but there is reason to believe that this can be improved.

*The magazine *Coal to Kilowatts*, published by The Detroit Edison Co., reports very effective use of the Penetron in inspecting tube and pipe in several of the power stations. These include: inspection of superheater tubes at Delray; insulated feedwater heater drain pipes filled with water; an interstage feedwater heater at Conners Creek; screen tubes at Trenton Channel; all tubes of a boiler at Congress Street Station.

TEMPERATURE LIMITS

(Continued from page 61)

covery equipment such as an air preheater in the gas path to recover that heat. Certain limits must be imposed on this equipment also to make it effective and to keep maintenance costs at a minimum.

Preheated Air

To salvage the high heat of the stack gas at the boiler outlet, an air preheater is placed between the generator and the stack. Its function is to preheat the combustion air by heat transfer between the stack gas and the air. Preheating the air improves combustion conditions and increases the efficiency of the steam generator by reducing the losses. The temperature to which the air may be heated depends upon the burning method, the equipment and the fuel. For fuels which are burned on grates, the preheated air should not be in excess of 350 F or maintenance of the grate will be high. If the fuel contains considerable moisture, as with lignite, the air temperature may be higher due to the cooling effect of the evaporating moisture. In that case, the temperature may go to a limit at 400 F. For pulverized fuel, the limit is 600 F as specified under the section on fuel properties, although the secondary air used in this method may go up to the ignition temperature of the fuel at the burner. The outlet temperature for the air heater has also been defined previously as depending upon the fuel properties. In burning pulverized fuel, where a heavy concentration of flyash is encountered in the stack gases, precautions must be taken to prevent condensation of the water vapor. Flyash of a certain composition in contact with sufficient water may become cemented and set up in the lower ends of the air preheater tubes and render it ineffective. This cemented flyash is extremely tenacious and in the usual air preheater installation, work space is insufficient to allow a quick cleaning operation. To prevent the condensation of water vapor in the air heater, the outlet temperature must be held above that condensation point or a limit of 300 F might be required.

Summary

After we have considered all the factors separately, an assembly of the information will show the relationship of the factors to one another. Figure 5 illustrates the assembly of the factors mentioned previously for a three drum water tube boiler with a superheater and air preheater. The fuel is assumed to be burned on a grate. Water walls have not been shown to simplify the diagram. The air heater illustrated is of the tubular type. Similar diagrams can be drawn for each type of fuel burning arrangement, boiler and heat recovery apparatus.

In specifying the temperature limits for the factors as given above, the author does not wish to suggest that they are conclusive or authoritative in every respect, but the point here is to classify some of the information available on the subject for the use of those who wish to obtain an over-all viewpoint without having to refer to a great many sources for the information expressed collectively herein. This material does not take the place of the infinite detail needed to completely design a modern steam generator, but by having some defined limits the better will the engineer be able to exercise his talents for design or efficient operation.

J. CALVIN BROWN NOMINATED AS 1951 PRESIDENT OF ASME

J. CALVIN BROWN, of Los Angeles, Calif., owner of the firm bearing his name in that city, has been nominated as the 1951 president of The American Society of Mechanical Engineers, it was announced yesterday (June 26). Mr. Brown heads a slate of new ASME officers, including four regional vice presidents and two directors-at-large, submitted by the society's nominating committee.

Formal election will take place in the fall by letter ballot of the membership, which totals more than 32,000 engineers. The new officers are to begin their terms at the conclusion of the ASME annual meeting in New York next December. Mr. Brown will succeed James D.

(Continued on page 106)

$ave Power and REFRIGERATION COST

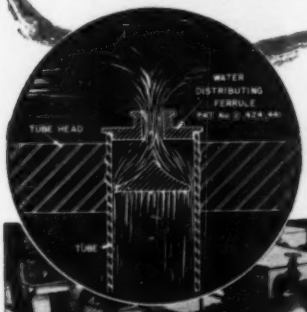
Vogt Condensers, because of their correct design, STEP UP the rate of heat transfer and STEP DOWN head pressures. With the liquid delivered at a lower temperature, smaller compressor capacity is needed, saving in original as well as operating costs.

One of the two basic types illustrated will fit your operations exactly. Install Horizontal Multipass (closed type) for use with clean waters. Where the water is hard, forms scale, contains mud or promotes fungus growth, Vertical Single Pass (film type) which can be cleaned in operation, are recommended.

Horizontal Multipass Condensers
(Closed Type)

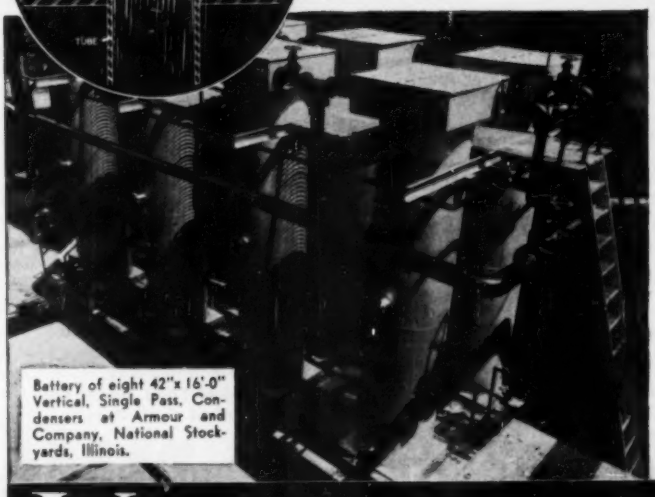
Water circulated in tubes traverses the length of the unit a number of times as determined by baffles in the heads.

375 tons capacity Multipass Condenser installation at Railways Ice Co., Belen, New Mexico.



Vertical Single Pass Condensers
(Film Type)

Patented ferrules give equal distribution of water to and over the surfaces of all tubes in a unit.



Battery of eight 42"x 16'-0" Vertical, Single Pass, Condensers at Armour and Company, National Stockyards, Illinois.

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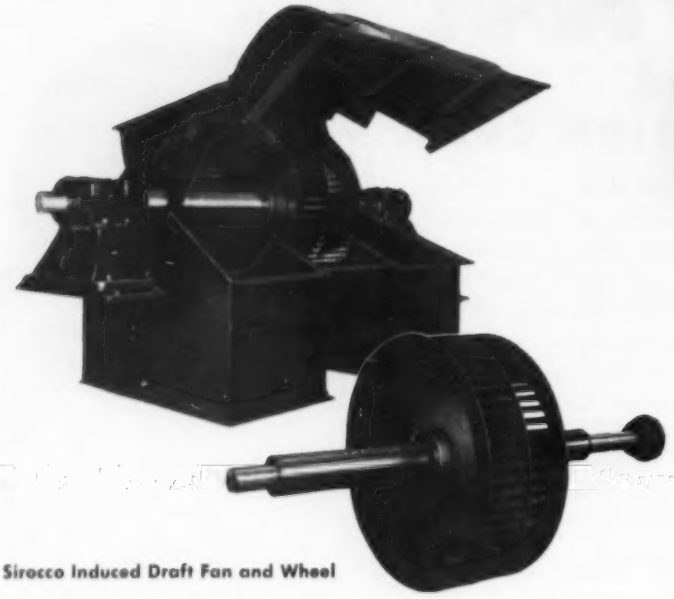
SIROCCO INDUCED DRAFT FANS

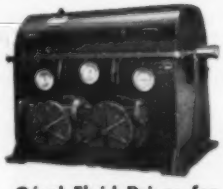
Standard of the World



Sirocco Induced Draft Fan and Wheel

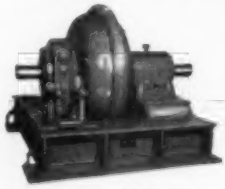
Heavy Duty Coils

American HS Forced Draft Fans



Gýrol Fluid Drives for Boiler Feed Pumps

Type ST Fly Ash Precipitators



Type VS Gýrol Fluid Drives for Mechanical Draft Fans

The Sirocco Induced Draft Fan (shown above) with die-formed forward curved wheel blades is designed and proportioned specially for induced draft work. **Now used on 1,000,000# /hr. steam boilers.**

The high static efficiency, low RPM, low tip speed, low inlet velocity, plus other important operating characteristics, make this fan particularly well adapted to severe power plant requirements.

For complete, concise, factual data on the Sirocco Induced Draft Fan, write for Bulletin 4424.

For data on other American Blower Mechanical Draft Equipment, Fly Ash Precipitators, Heavy Duty Coils and Gýrol Fluid Drives for fan control and boiler feed pumps—consult your nearest American Blower Branch Office.

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Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION

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FORCED BOILER OUTAGES TURBINE SANDBLASTING, ELIMINATED!

BEFORE Allis-Chalmers Silica Removal Service	**AFTER** Allis-Chalmers Boiler Feedwater Service Installed
57 Boiler shutdowns in 33 months with 834 boiler hours of unscheduled outage.	Boilers and turbines operate 14 months between scheduled cleanings!
133 Tubes replaced. 29 Tubes welded.	*No* boiler tube failures!
Turbines sandblasted every 4 months.	*No* turbine sandblasting!
Power Production down 50% before each cleaning.	Rated power capacity is maintained!

ACTUAL CASE!

SILICA REDUCTION IN BOILER FEEDWATER with Allis-Chalmers chemicals and treatment produced these startling power plant economies at the Southern Advance Bag & Paper company, Hodge, Louisiana.

One of the leading manufacturers of paper bags in the south, this company has a daily steam production average of 9,350,000 lbs from 10 boilers serving 5 turbines generating 12,000 kw, a number of turbine-driven auxiliaries, and turbines operating paper machines.

Raw water analyses taken over a period of three years at Southern Advance show a silica reduction of 94% due to the use of Allis-Chalmers chemicals.

You can get similar results from A-C water conditioning service, chemicals and equipment.

Whatever your industry — paper, petroleum, food, steel — you'll get prompt, convincing results with Allis-Chalmers water conditioning service. An expert representative is available, ready to recommend proper chemicals or help select the right process for your power plant requirements.

Get in touch with him today at your Allis-Chalmers Office for complete information.

JOHN B. DAVIS, with 15 years experience in power plant water conditioning, is one of the A-C specialists located around the country to advise you of correct water conditioning equipment, chemicals and service.

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Gentlemen:
Please send me specific information on A-C chemicals for feedwater treatment.

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ECONOMIZERS • FANS • AIR HEATERS • CINDERTRAPS

(Continued from page 102)

Cunningham, president of Republic Flow Meters Co., of Chicago.

A mechanical engineer and attorney at law, specializing in patent, trademark and copyright litigation before the United States courts, Mr.

J. Calvin Brown

Brown became a member of the society in 1928. He served as manager of the ASME in 1943-44, and vice president, 1945-47 and 1947-49.

Regional vice presidents nominated are:

Henry Reginald Kessler, manager, Republic Flow Meters Co., New York.

Stephen Dewey Moxley, vice president, American Cast Iron Pipe Co., Birmingham, Alabama.

Dr. John. T. Rettaliata, dean of engineering, Illinois Institute of Technology, Chicago.

Carl J. Eckhardt, (renomination) professor of mechanical engineering and superintendent of utilities, University of Texas, Austin.

MINIMIZING HEAT LOSS

(Continued from page 67)

increase in over-all efficiency as well.

In conclusion, the very form which such a generator must take, that is as a number of progressively cooler concentric rings about a central source of energy at intensely high temperature with the outermost ring being at a very moderate temperature (100 F) favors the safety of an experimental model under operating conditions, inasmuch as 622 kw is not a large energy release and could be maintained with a small amount of fissionable material.

References

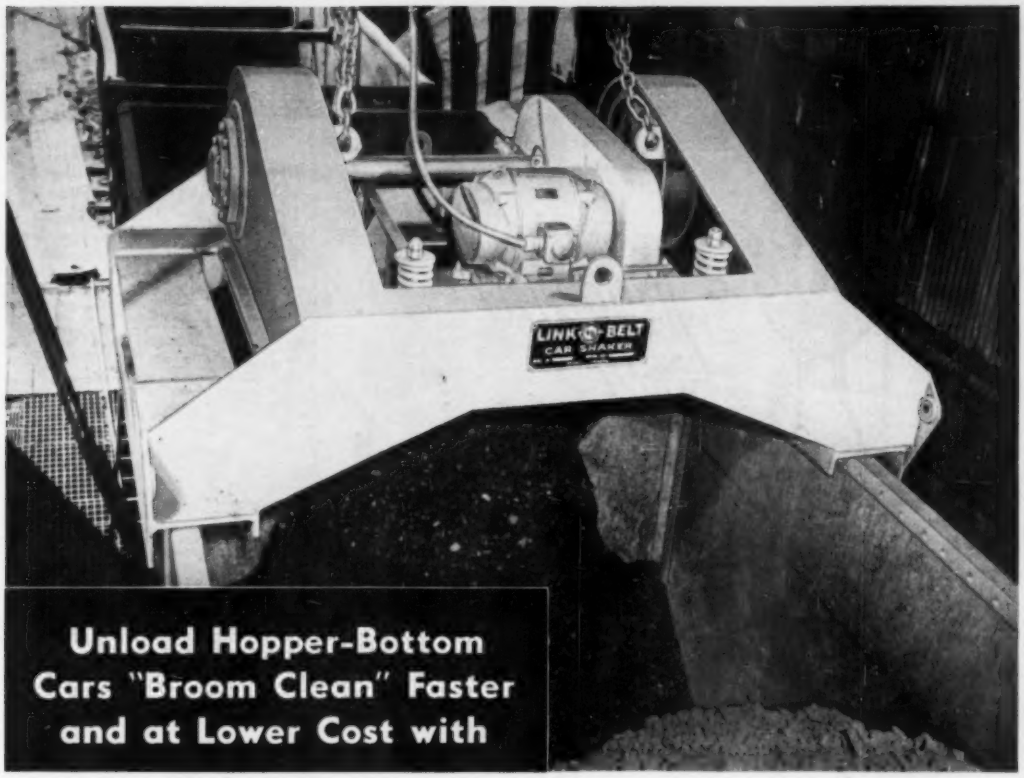
1.) Problems encountered in Thermoelectric Generator Design—C. D. Bassett
Power Generation, January 1950

2.) A Practical Thermoelectrical Generator
C. D. Bassett
Power Generation, August 1949

3.) Recent Work in the Field of High Pressures—P. W. Bridgman
Review of Modern Physics, Vol. 18, January 1946

4.) The Influence of Pressure on the Melting Point of Certain Metals—Johnston and Adams
American Journal of Science, Series 4, Vol. 31, Pp 501-17 (1911)

5.) The Physics of High Pressure—P. W. Bridgman
Chapter 10, P. 295
G. Bell & Sons, Ltd., London



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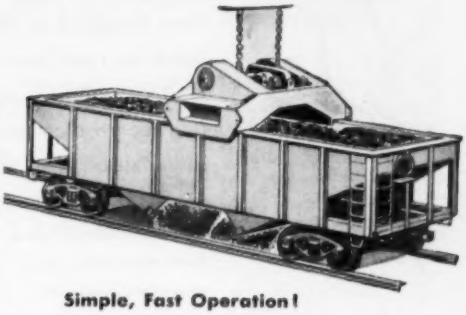

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New ENGINEERING BOOKS

CORRECTION NOTE
Diesel Engineering Handbook, 1950 Edition (7th Edition)

In the review of this Handbook, page 106, POWER ENGINEERING July 1950, the price of the book was incorrectly given as $5.00. It should have been given as $7.50.

Electric Circuit Theory by H. Tropper. First Edition; 6 by 9 in.; 164 pages; cloth; published by Longmans Green and Co., Inc., 55 Fifth Avenue, New York 3, N.Y.; 1949. Price $2.75.

This valuable little book seems to present a unified account of some of the fundamental aspects of electric circuit theory, and shows how the solution of many network problems may often be simplified by the application of a few fundamentals principles.

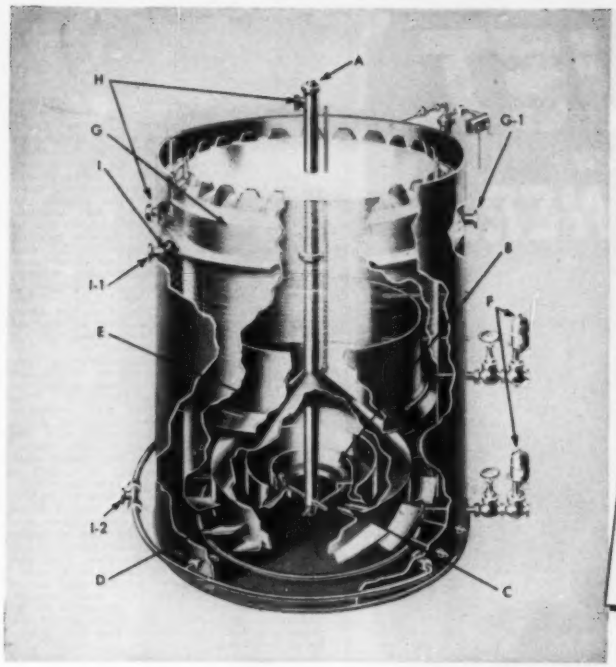
The book contains the substance of lectures which the author gave over a number of years to graduate students at Queen Mary College, at the University of London. As the author points out in the preface, in a book of this small size it is not possible to attempt a complete treatment of so vast a subject as electric circuit theory. The object is to give a unified account of some of its more fundamental aspects and to show how the solution of many network problems can be simplified. The analysis of electric circuits is based on the two Kirchhoff's Laws. Throughout the book the treatment of steady state and transient theory is based upon the important Superposition Principle. Dr. Tropper first discusses this principle in detail and then goes on to show its application to a number of branches of linear circuit theory. The dual circuit and the method of symmetrical components including the fault analysis of 3-phase systems. The exposition of electric transients begins with Heaviside's Expansion Formula, the use of which is explained before its validity is considered. After discussing the relationship between a function and its frequency spectrum, the Laplace Transformation is introduced and the expansion formula is then proved by the transformation method.

The reader is assumed to be familiar with the elements of a-c circuit theory, in particular with the symbolic method of solving a-c problems. In an appendix on complex algebra, a few simple facts which are used in the text are explained. The book should prove very easy to those having attained a standard equivalent to engineering or physics and it should also be of service to the practicing engineer.

• • •

Principles of Engineering Economy by Eugene L. Grant. Third Edition; 6½ by 9½ in.; 623 pages; cloth; published by the Ronald Press Co., 15 E. 26th St., New York 10, N. Y.

This book by the Professor of Economics of Engineering at Stanford University discusses engineering problems from the standpoint of cost. Arthur M. Wellington, almost 50 years ago, made the classic remark that engineering was the art of doing well for one dollar what any bungler could do for two dollars. This fact is still as true today as it was when Mr. Wellington stated it and it is this aspect of engineering that Eugene Grant discusses in great detail in this splendid book. What the average engineering student needs most of all is the point of view that ultimate economy is a problem with which the engineer must be concerned. This point of view involves the realization that quite as definite a body of principles governs the economic aspects of an engineering decision as governs its physical aspects. The importance of engineering economy is likely to be more effectively emphasized, and the principles of comparison more likely to be covered with less application of effort, if these principles are presented in a separate course. This book is a text for just such a purpose. Although the book has been written primarily for students of engineering, it will be found useful by practicing engineers and industrialists as well.



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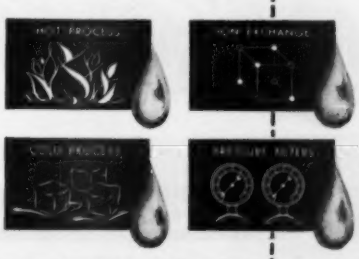

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Engineering Mechanics by Archie Higdon and William B. Stiles. First Edition; 6½ by 9½ in.; 506 pages; illustrated; cloth; published by Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y.; 1949. Price $6.65.

According to Professor H. J. Gilkey, Head of the Department of Theoretical and Applied Mechanics at Iowa State College, there are three kinds of courses in engineering mechanics. In his foreword to this book by Archie Higdon and William B. Stiles, Professor Gilkey points out that there is the philosophical type of engineering course which places the major emphasis on theory and mathematics and is usually taught under liberal arts auspices. Then there is the applied mechanics which is more empirical and stresses getting out the answers without much mastery of the underlying theory. Finally, there is the more strictly applied course in engineering mechanics where the major emphasis is placed on the free-body-diagram with an effort at having the student visualize each step of the analysis and problem solving.

Professor Gilkey places engineering mechanics in this last category which he says is the type of mechanics taught in most United States institutions. This book is a basic text for a 2 semester course, stressing the fundamental principles of engineering mechanics and the development of the ability to apply them. Equal emphasis is placed on statics and dynamics. Wherever possible an action is illustrated by the use of free body diagram or other pictorial and semi-graphical aids. These supplement rather than replace the application of elementary calculus which is stressed by the authors. There are over 1100 problems, 100 of them set up as illustrative examples. The appendix includes answers to the even numbered problems and sample one hour tests and several two hour final examinations. A solutions manual soon to be published will contain solutions to all the problems and answers to the odd numbered problems.

• • •

Phenomena, Atoms and Molecules by Irving Langmuir. First Edition; 6¼ by 9¼ in.; 436 pages; cloth; published by the Philosophical Library, Inc., 15 E. 40th Street, New York 16, N. Y.; 1950. Price $10.00.

Strangely enough, despite Dr. Langmuir's many papers before scientific and engineering societies during the past 30 years, this is his first book. As might be expected, it is a very interesting book and one that everyone who has followed Dr. Langmuir's researches at the General Electric Company's Research Laboratory will want to read. In it he sets down his thoughts, observations and conclusions from his lifetime in the world of science. His approach to world science is broad in scope, yet precise in detail, covering the human, sociological and international aspects of modern science, along with a comprehensive discussion of atomic progress and possibilities.

Inventor of the gas-filled tungsten lamp, pioneer in the development of the high vacuum electron tube, the first to isolate atomic hydrogen and demonstrate the importance to chemistry and physics of single layers of atoms and molecules, Dr. Langmuir here offers a work that possesses importance and timeliness.

For many years, Dr. Langmuir has been particularly interested in the action of atomic hydrogen and it is not surprising, therefore, to find three of the 18 chapters in the book devoted entirely to various aspects of atomic hydrogen. Aside from the purely scientific chapters, the first chapter on science, common sense and decency will be of particular interest to everyone, both scientists and laymen alike. We cannot recommend this book too highly.

• • •

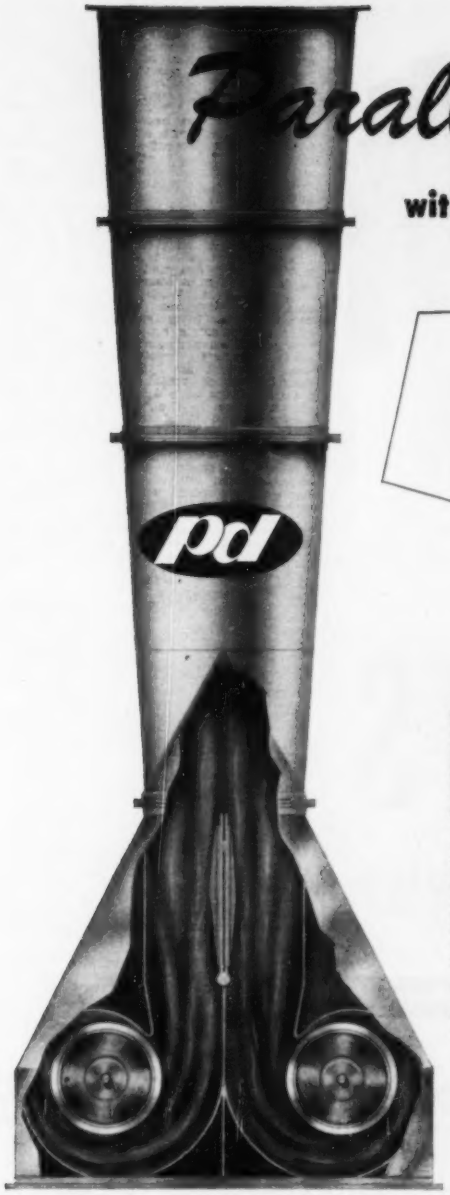
Hydroelectric Handbook, by William P. Creager and Joel D. Justin; 2d Edition; 1151 pages; illustrated; size 6 by 9 in.; cloth binding; published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $12.50.

Since the first edition of this book was published in 1926, an enormous advance and accumulation of data on design of hydroelectric power developments has taken place. The progress of the art has been so rapid that it was found necessary in preparing this edition to rewrite most of the text of the first edition.

For many years this handbook has been

Parallel Operation

with a BACKGROUND of OVER 30 YEARS



As shown in the illustration, either of two fans may be used and will generally carry approximately 70% of the normal load. The second fan can be arranged to start automatically when maximum capacity of the first fan has been reached.

Thus, a basic lower operation cost is realized and this safety factor assures continuous performance in the event of bearing or drive failure. In such an emergency, the boiler can be operated at 70% of normal load instead of a complete shut down, an important factor in large installations. Two boilers, operating from a Single, Twin Fan Stack can be arranged to operate either boiler from either fan.

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one of the authoritative sources of data on design and operation of a modern hydroelectric power development. For those concerned directly with design, it provides an accurate picture of the problems involved and also provides sufficient data for preliminary design, estimates of costs and reports. However, for obvious reasons a complete treatment for designing all the structures necessary in a hydroelectric development cannot be given in a book of the present size, hence the designer must consult other detailed works on the complete design of individual structures, appurtenances and components.

For the operating engineer the book is equally valuable, even though he is not responsible for design; but as in all similar cases in engineering, a thorough knowledge of the basis on which his equipment is designed is of the highest value to the man operating it.

The book is divided into four main sections or divisions. The first 16 chapters cover the investigation and planning of a hydroelectric project. This includes analysis of such factors as rainfall, evaporation, runoff, various hydraulic measurements and flood flow. Included are descriptions of various types of hydroelectric plants with discussion of the economic factors in their operation.

Second and third sections discuss and compare the various types of dams and present the general design methods involved in their construction.

The final section deals with the mechanical and electrical equipment of a hydroelectric plant and the methods of operation of that equipment. It includes details of hydraulic turbines and their parts and auxiliaries, electrical system design, generators, exciters and transformers, switchgear and transmission lines, and the final chapter deals with operation of hydroelectric plants.

The reader of this book will acquire a very good grasp of the reasons why hydroelectric plants are built as they are and of the way in which details of equipment and methods have developed right up to the present time. All power engineers should have a considerable basic knowledge in this field even though their primary activities may be in steam or internal combustion work.

This book, then, should be of the widest interest throughout the entire engineering field, and especially valuable to power engineers everywhere.

HELPFUL BULLETINS

(Continued from page 36)

tems, water storage tanks, centrifugal pumps, gasoline lines dry cleaning solvent filters. Included are hookup diagrams, cross sectional drawings of the traps, physical data and list prices of cast semi-steel and forged steel traps, both direct lever action and spring loaded snap-action types. Armstrong Machine Works.

127 **Steam Traps**—Illustrated Bulletin 101 contains complete information on a line of steam and air traps. Includes capacity tables, sizing information, data on a blast trap attachment and double valve mechanism and company's new Venturo-Valve. The C. E. Squires Co.

LUBRICATION

128 **Grease Application Devices**—The development and use of many types of lubricating devices are discussed in an excellent article in Vol. 36, No. 9 of Lubrication, company's technical publication on lubricants. Covers the pressure gun, spring type grease cups and several types of power driven grease lubricators, explaining such points as the judicious use of pressure measured lubrication, pumpability characteristics of lubricants. Text is illustrated with photos and sketches. Copies of this publication are available to qualified power engineers. The Texas Co.

129 **Lubricant Additive**—This 4-pp pamphlet describes a colloidal graphite dispersion in oil for blending with petroleum products, to use in lubricating internal combustion engines, and industrial machines, a concentrated dispersion of colloidal graphite in mineral spirits for use in high temperature lubrication of conveyor chains, car wheel bearings, permanent mold push pins, foundry ladles; also

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Water Disposal
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All these water problems and expenses eliminated by FIN-FAN

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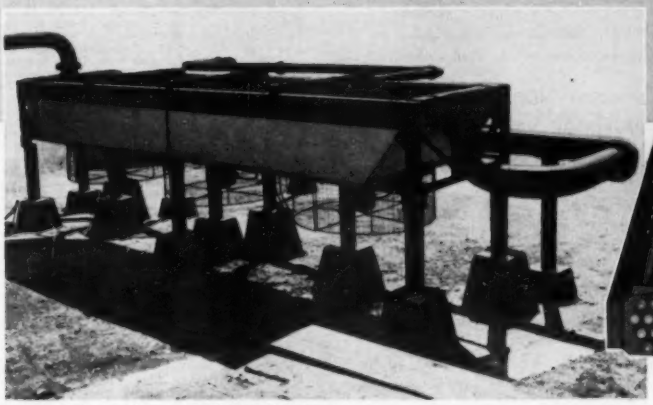
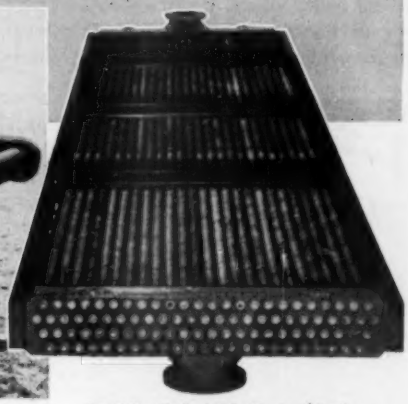


Single Fin-Fan Exchanger installed on the ground.



G-R K-Fin Air-Cooled Section used in the Fin-Fan Exchanger.

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Write for Bulletin 1231 describing these many-purpose, many-benefit units in detail and for recommendations for your heat transfer needs.

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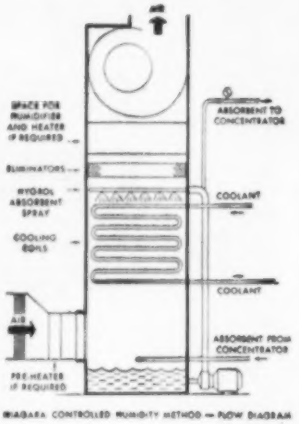
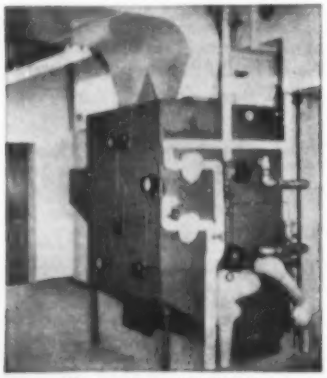
Using "Hygrol" hygienic absorbent liquid, this method gives complete control of temperature and relative humidity. Especially, it is a better way to obtain dry air for drying processes, packaging hygroscopic materials, preventing moisture damage to metals, and obtaining better quality for chemical process products and food products—or in obtaining better results in comfort air conditioning for office or laboratory at lower refrigeration costs.



NIAGARA CONTROLLED HUMIDITY METHOD — FLOW DIAGRAM

Food Packaging under Controlled Humidity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The diagram shows how filtered air is dehumidified by passing thru a spray of "Hygrol"—a liquid absorbent which removes air-borne moisture. This liquid is hygienic and non-corrosive; it contains no salts or solids to precipitate and cause maintenance troubles. It is continuously re-concentrated at the same rate at which it absorbs moisture, providing always the full capacity of the air conditioner, automatically.

Units provide a range of capacities from 1000 to 20,000 C. F. M. Multiple unit installations are in use successfully. Records of results are available. For further information, write Niagara Blower Co., Dept. E, 405 Lexington Ave., New York 17, N. Y.

a concentrated dispersion of colloidal graphite in alcohol for fast drying applications. Also discusses methods of blending, means of calculating dilutions and advantages of heating during blending. Acheson Colloids Corp.

SAFETY

130 Fundamentals of Fire Extinguishment—Recommended reading for fire prevention week or any other week is Form F-5020, a 4-pp illustrated discussion of what fire is, how fires are classified and the proper methods of extinguishing them. Covers characteristics of flammable liquids, flash point and fire point, and gasoline as a fire hazard. Ansul Chemical Co.

131 Face Piece for Gas Masks—Bulletin 504, 4 pp, introduces a full-vision face piece with dead-air check valve to prevent dead air from going down the air intake passage. Special features of the face piece are described and illustrated and its use with chin-style and chest style cannisters and hose mask connection are pictured. Acme Protection Equipment Co.

OTHER EQUIPMENT

132 Steam Condensers with Reverse Flow—Eight-pp Catalog 410-1 describes company's "self-cleaning" reverse-flow condenser for power plant service, designed to virtually eliminate cleaning down time and, in the case of divided water box condensers, eliminate necessity of operation at partial load. Explains and illustrates direction of water flow and reversing flow by tandem sluice gates, without sluice gates and in single pass condensers. C. H. Wheeler Mfg. Co.

133 One-Minute Water Tests—Rapid, simple and accurate tests for determining water hardness are described in Bulletin 1RE50, 4 pp. Procedures, reagents, and equipment for the new tests are pictured and described. The test procedure is said to take 1 min to complete and because of clear-cut color change at end-point to afford increased accuracy. Bulletin tells how tests may be used to determine total water hardness, hardness due to calcium alone and hardness due to magnesium alone. Hall Laborstories, Inc.

134 Tube Expansion Control—Bulletin 45, 6 pp, describes and illustrates control equipment for the automatic and accurate regulation of the amount of expansion obtained in rolling tubes in condensers and heat exchangers. Discusses advantages of the control and tells how it operates. Also catalogs expanders for use with control, giving sizes and prices. The Airetool Mfg. Co.

135 Hydraulic Cylinders—Twenty-eight-pp Catalog 233-A offers engineering and ordering data on company's hydraulic cylinders for practically every mounting requirement, for applications where a controlled push, pull, lift, press or clamp is desired, and for working pressures to 1500 psi. Generously illustrated, covers design, construction and operating features, specifications and dimensions. Includes alignment chart giving horsepower for hydraulic cylinders. Hanna Engineering Works.

136 Industrial Dry Coolers—Illustrated Bulletin DC-50, 12 pp, presents company's line of dry cooling equipment for small, "in-between" and heavy-duty cooling jobs and includes three recently introduced models. Two of these are small "portable" units and the third a medium-size unit. Although designed primarily for cooling engine jacket water, they can also be used for cooling natural gas, lube oils, fluids of refining stages. Bulletin includes dimensions and weights, also rating tables for cooling water. The Marley Co., Inc.

137 Stoker Story—Sixteen-pp Bulletin 501 on company's stokers tells what they do and where they're doing it. Describes stoker's design and operating features and includes a cutaway sectional view showing the type of fuel bed it produces. Recent installations are described and pictured and operating data provided. Stowe Stoker Div., The Johnston & Jennings Co.

138 Portable Gas Torch—Form 522A, 2 pp, presents a cartridge-filled liquefied petroleum gas torch that lights instantly without preheating, reaches 3000 F and burns in any position. Its light weight and small diameter make it easy to operate in hard-to-reach places. Torch and its component parts are fully described and illustrated by sketches. Photos show some of its uses. Otto Bernz Co., Inc.

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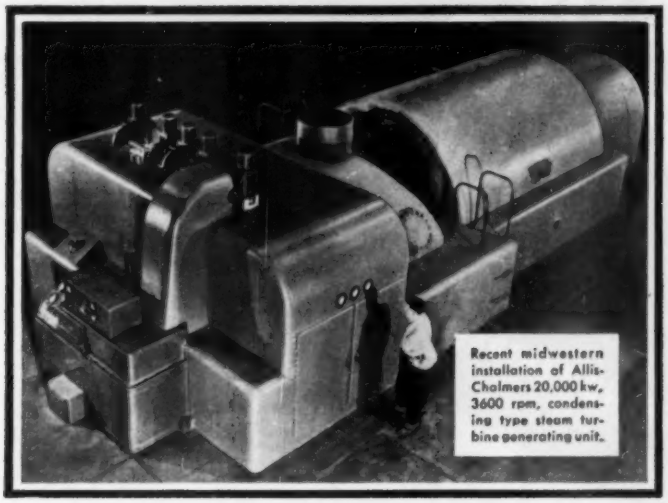

Recent midwestern installation of Allis-Chalmers 20,000 kw, 3600 rpm, condensing type steam turbine generating unit.

OVER 70 PERCENT of U. S. electric power now comes from steam turbine driven generators! This is proof that industry increasingly recognizes the dependability and economy of steam turbines in supporting America's industrial expansion.

With a background of *80 years* building steam prime movers, Allis-Chalmers continues to refine and improve steam turbine generator units. Progress is to higher pressures and temperatures, providing more economy, with even greater reliability.

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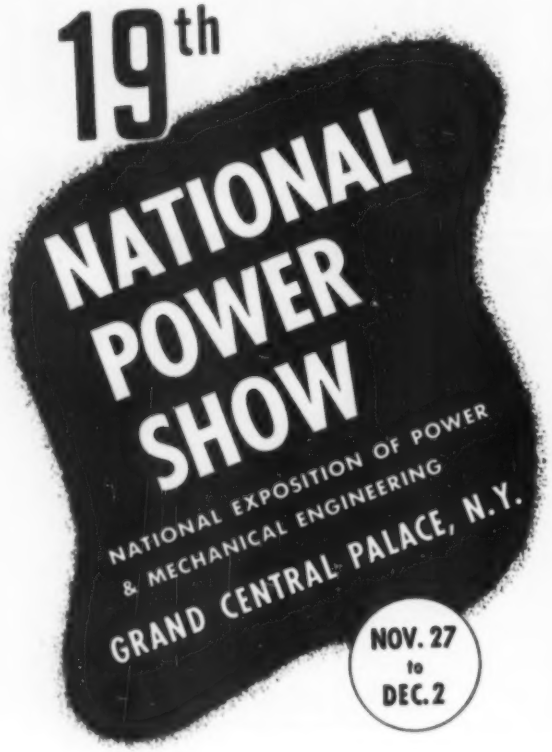

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139 Soot Eliminator—This folder describes company's chemical compound which acts upon and reduces residual deposits of combustion in boilers using coal, coke, oil or waste fuel. It is intended to break up fly ash into a fine mist which doesn't settle or deposit and to virtually eliminate soot and firescale. Also discussed is a fuel oil treatment for eliminating sludge and moisture. Consolidated Engineers Co., Inc.

140 Moisture Eliminator—A device described as a "pet cock with a brain," which automatically ejects moisture and oil from air brake systems, air line brakes and air compressors is explained and illustrated in this small folder. Lists advantages, gives price. Master Equipment Corp.

CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

ELECTRICAL

201 D-C Generator — Illustrated Bulletin 05B7229, 20 pp, describes the construction of units larger than 150 kw or 0.3 kw per rpm, including two- and three-wire generators and exciters, both engine and coupled type. It also discusses the operation of shunt wound and compound wound generators in parallel, and supplies information on company's marine units. Includes description of "frog leg" armature winding widely used on motor-generator, set generators of 100 kw and larger, synchronous converters of 200 kw and larger and large low speed generators. Allis-Chalmers Mfg. Co.

202 Synchronous Motors — High speed synchronous motors are described in 4-pp bulletin PB 5600-1. The bulletin is packed with descriptive matter and photographs explaining features of the motors rotor and stator. Mechanical modifications also are illustrated. Elliott Co.

203 Low-Speed Synchronous Motors—Publication GEA-5332, 8 pp, illustrates typical installations of efficient high-power factor, constant-speed drives, describes their construction features, and indicates mechanical modifications and performance data. Covers three-phase and two-phase motors in company's "600" series with frame sizes of 6184 and larger and ratings from 20 to 15,000 hp. Photos show detail of stator and rotor design. General Electric Co.

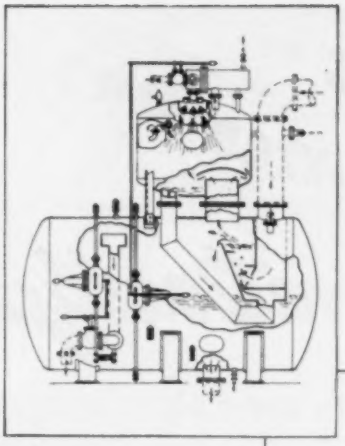
204 Care of A-C Rotating Equipment—To promote intelligent and consistent maintenance of electrical machines, company has published Bulletin 05R7417, which is a series of articles by Fraser Jeffrey. Contents of the 24-pp booklet cover preventive maintenance and machine repairs, and include such subjects as drying moist insulation, measuring insulation resistance, bearing clearances and proper machine applications. Machine repair chapters include data on stator coil and slip ring rotor repairs, balancing of rotating equipment. Allis-Chalmers Mfg. Co.

INSTRUMENTS AND CONTROLS

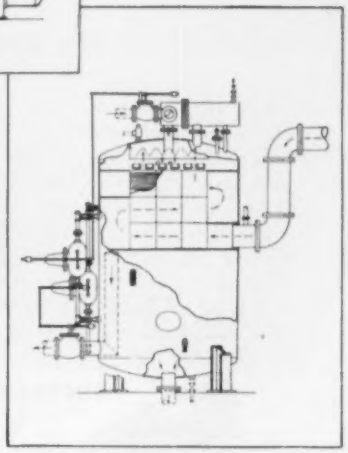
205 Smoke Density Recorder — Bulletin 211, 4 pp, tells how company's bolometer-type smoke density recorder promotes efficient furnace operation and how it helps in the battle against smoke nuisance. It describes and illustrates the smoke detector which consists of a bolometer receiving and measuring radiation from a sealed beam light source. Recorder specifications, installation requirements, and measuring circuit details are also discussed. Bailey Meter Co.

206 Boiler Water Level Control — Bulletin 467 describes completely the installation of boiler water level control equipment at the Blackhawk Generating Station, Wisconsin Power & Light Com-

Spray



or Tray



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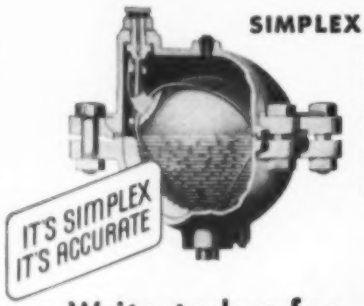

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PARTIAL CONTENTS

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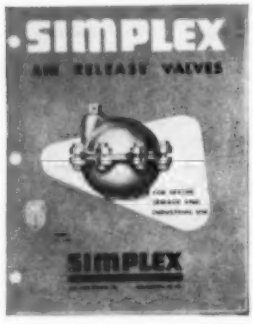
- How Simplex Takes Care of Air in Pipes
- Methods of Installation
- Design and Construction Details



Write to Simplex Valve & Meter Co., Dept. 10, 6783 Upland St., Phila. 42, Pa.

SIMPLEX

VALVE AND METER COMPANY

pany. Photographs of the installation are presented as is a schematic layout of the entire station. Northern Equipment Co.

207 Instrument and Control Panels—Bulletin 773, 8 pp, explains how company's panels are made and where they are used. All operations of fabrication are discussed and illustrated—layout, cutting, drilling, welding, fitting, painting, wiring. Particular features like electric clocks, pressure gages, transformers, name plates, push-button stations and signal lights are discussed. Also includes many photos of panel installations. The Hays Corp.

208 Remote Reading Flow Meters—Data Book 702, 32 pp, fully illustrates and explains flow measurement problems and offers suggestions for their solution. Meter bodies, differential devices and reading instruments are fully described and a special section is included on wide range and reverse flow. Republic Flow Meters Co.

209 What's Going On Inside?—Sight flow indicators for insertion into pipe lines carrying oil, steam, water, cooling liquids are described in Bulletin DD, 4 pp. Covers both cylinder and window types, gives sizes and prices. Also catalogs gage glasses, tubing, other safety equipment. Ernst Water Column & Gage Co.

210 Flow Meters—Bulletin 400-F2, 8 pp, features company's meter for measurement of steam, air, or gas flow in 1 or $1\frac{1}{2}$ in. pipe lines, and designed for installation directly in the line being metered. Illustrated with photos of meter, sectional and dimensional drawings, the bulletin explains how meter operates and discusses its advantages. Gives typical specifications and includes correction factor charts and capacity tables. Builders-Providence, Inc.

211 Pneumatic Metering Element—Company's pneumatic machine used as the metering element in the measurement and control of steam, gas and liquid flow, liquid level, pressure differential and similar applications, is illustrated and described as to application and operating characteristics, in Bulletin 2150. Design and operation of the machine are shown in full color drawing. Dimensional, ordering data included. Hagan Corp.

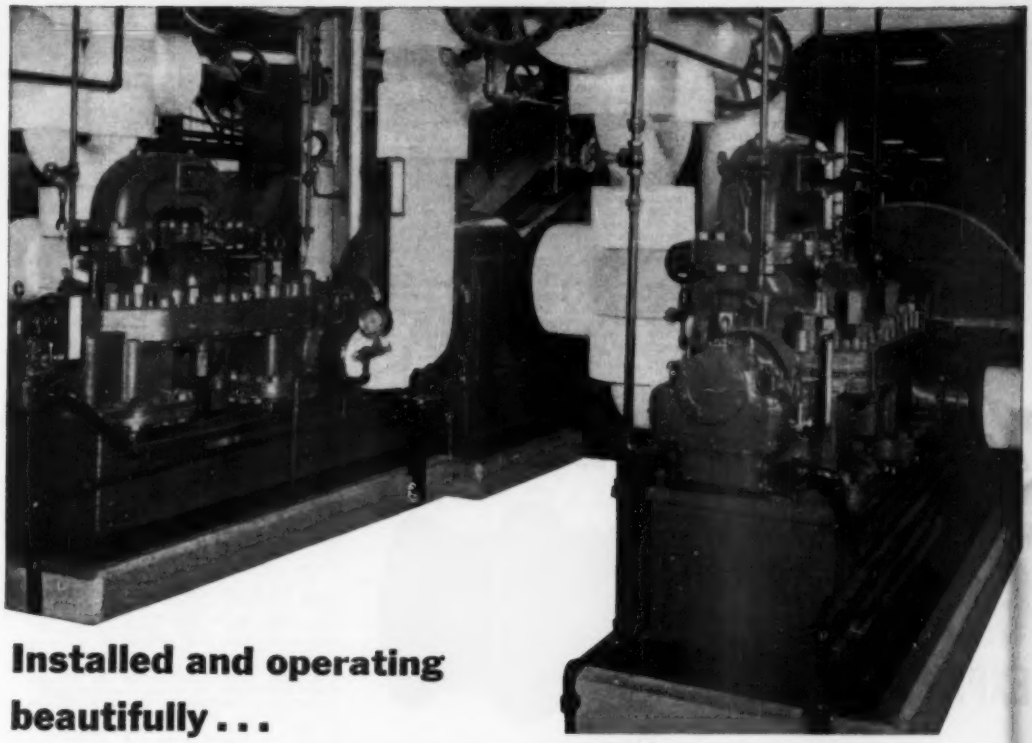
212 For Practical Men—That's the title of this 24-pp pocket-size booklet presenting insulation testing in simple language. Packed with maintenance hints, it explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester and justifies its cost in terms of long run economy and prevention of shutdowns. Discusses the Megger as a trouble-shooter, pointing out its functions and telling how to get the most out of it. There's also a chapter on handling wet equipment. James G. Biddle Co.

213 Temperature Measuring Instruments Catalog ND4-33-461, 34 pp, describing the company's instruments for measuring the temperature of generators, motors, condensers and transformers, covers a wide variety of instruments, portable and automatic indicators, for checking in any order on temperatures. Reference also is made of new and specialized instruments for measuring in rapid succession a number of bearing temperatures. Leeds & Northrup Co.

VALVES, TRAPS, PIPING

214 Piping Materials Catalog—Corrosion resistant valves and piping materials are covered in illustrated circular No. 320, 32 pp. Contains information on manufacturer's complete line of valves, fittings, fabricated piping and pipe coils to meet a wide range of corrosive conditions. Listing includes both photos and cutaway drawing of models, complete specifications, sizes and prices. Includes a description of alloy metals used and a corrosion questionnaire. Also included are condensed recommedations on the selection of piping materials according to service requirements as well as a pictorial chart showing basic types of valves with names of their parts. Crane Co.

215 Valves Bulletin — Catalog Section 12-H describes various types of company's cast steel pressure-seal bonnet valves. Information on choosing the best size valve for your service is given in one page of the booklet under the title, "Correlation of Valve Size and Pressure Drop." Design and construction advantages of the valves are given and tables of pressure and temperature ratings. Details of design including operating mechanism, body design, disk piston, and other features are ex-



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Write for Bulletins 241 and 244 giving complete details on Warren Pumps for higher pressure services. P-12

WARREN PUMPS

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plained. Dimensional details are given in tabular form accompanied by dimensional line drawings. Edward Valves, Inc.

216 Control Equipment—General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Catalog illustrates and describes in detail: venturi tubes and meters, controllers, gages, manometers, pitot equipment. Includes capacity tables, dimensional data, specifications, layout drawings. Simplex Valve and Meter Co.

217 General Service Valves—Bulletin E-160, 16 pp, describes and illustrates the design and construction of company's quick-operating valves, explaining their application to blow-off service and on fire protection, chemical process, soot blower, water column blow-down, and other types of pipe line. Included are tables of dimensions, weights and list prices for straight lever and rack-and-pinion types, inside packed and with outside stuffing box and with screwed or flanged ends. Everlasting Valve Co.

218 Unions and Fittings—Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special construction features and other advantages. Also illustrates all equipment offered, along with sizes, materials, current price list. E. M. Dart Mfg. Co.

219 More Data on Strainers—In response to demand this revised edition, Bulletin S-203, 6 pp, contains greater and more up-to-date data on screwed strainers as well as expanded details on flanged types. Fully illustrated with photos of the strainers and screens used in them, it explains function of the strainers and provides material specifications, pressure and temperature data, dimensions and prices. Also tells how to install strainers and replace screens. Yarnall-Waring Co.

220 Welding Fittings and Flanges—Catalog and Engineering Data Book 211, a 262-pp manual, provides complete dimensional data, weights and prices on company's welding fittings and flanges. The engineering section contains practical, illustrated information covering welding fittings and flanges under varying conditions of temperature and pressure, location and materials processed. Discusses their use in different piping systems.

A section is devoted to welding fittings and flanges in special metals and alloys. The technical section covers properties of pipe, rating of pipe, fittings and flanges, line expansion and flexibility, support and anchorage of piping and flow of fluids.

Distribution of this catalog is limited to major users of industrial piping. (Please include your title when requesting it.) Tube Turns, Inc.

221 Steam Traps and Temperature Controls—Here is a comprehensive catalog comprising many of company's bulletins on steam traps and related equipment, including an illustrated steam trap chart for easy selection of the right trap for each application. Provides data on boiler steam traps, air eliminators, thermostatic steam traps and air vents, inverted bucket steam traps, temperature regulators and cooling controls, steam and water mixers, thermostats and strainers. Generously illustrated with photos, engineering drawings, catalog contains full dimensional and application data, prices. Sarco Co., Inc.

222 Steam, Air, Gasoline Traps—This 32-pp illustrated catalog, No. 250, describes five types of thermostatic steam traps for pressures to 225 lb; expansion steam traps for pressures to 250 lb; weight-operated traps for steam, air and gasoline service, pressures to 1500 lb; piston-operated steam traps for pressures to 650 lbs, and also steam, air and gas separators. Includes capacity tables, installation diagrams as well as a discussion of typical applications, and a section giving data, charts and formulas for determining proper size trap. W. H. Nicholson & Co.

223 Handbook on Fittings and Flanges—Catalog wf-1950, 84 pp, is packed with working information on manufacturer's seamless carbon steel welding fittings and forged steel flanges. In addition to presenting standard schedules with their specifications, list prices and sizes, this book gives information on dimensional tolerances; American standard flange facings with dimensions; thread standards and threading practice; service pressure ratings, physical and chemical requirements for flanges, nuts and bolts; plus sizes and wall thicknesses of welding fittings stocked in other metals such as stainless steels, Inconel, pure nickel or Monel, aluminum, deoxidized red brass. Grinnell Co., Inc.

224 How to Choose and Use Air Traps—Bulletin 202, 4 pp, describes manufacturer's complete line of air traps, covering their selection and installation for automatic drainage of moisture from compressed air intercoolers, aftercoolers, receivers, separators, and drip points. Illustrations of the various airtrap models, their applications and how they work are also presented, and physical data and prices included. Armstrong Machine Works.

225 Rubber Expansion Joints—Eight-pp Bulletin AD 137 tells about the application, construction, styles, service and advantages of the company's line of rubber expansion joints. Includes ordering information and a table of dimensions which is accompanied by dimensioned line drawings. The Garlock Packing Co.

226 Flanges for Severe Service—This 4-pp bulletin describes and illustrates a flange specially developed for services involving severe abrasion and corrosives, and for use in suction and discharge service. Photos and sketches illustrate the flange and its parts. Bulletin also covers a flexible rubber pipe for use with abrasive or corrosive material, as well as an acid- and corrosion-resistant duct, listing solutions this duct will handle. Goodall Rubber Co.

BOILERS AND AUXILIARIES

227 Working Pressure Data Card—Maximum allowable working pressures for water tube and fire tube boilers are compiled in a handy reference table. Technical Data Card No. 113 A. It lists pressures in pounds per square inch for seamless and electric resistance welded carbon steel tubes or nipples for different diameters and gages of tubes conforming to ASME specifications. Chart is punched for binding. The Babcock & Wilcox Tube Co.

228 Dowtherm Vaporizer—Bulletin No. 48-2, describing manufacturer's Type "A" Dowtherm Vaporizer tells how this

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EXPANSION JOINTS

QUICKLY, EASILY INSTALLED. Flared end of joint receives "FLANG-LOK" Floating Flange—a readily bolted split type. It is only necessary to turn flange (not joint or pipe) to align bolt holes with those of connecting flange.

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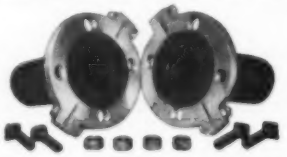

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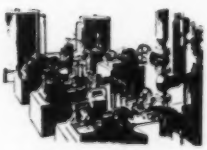

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BA-187

unit is designed to evaporate Dowtherm in such a way as to provide dependable operation at maximum temperatures, discussing its construction advantages in detail. It is illustrated with photos of the vaporizer and includes a dimensional drawing, vaporizer chart and specifications. Also included is table showing general properties of Dowtherm "A." The Wickes Boiler Co.

229 **Tube Expanders**—Bulletin 380, 8 pp, covers manufacturer's line of tube expanders for maintenance of high pressure boiler tubes, superheaters, economizers, circulating tubes, steam generators and like equipment. Various models are illustrated by photo and described as to application. Thomas C. Wilson, Inc.

230 **Bent Tube Boiler Data**—This 20-pp booklet is filled with engineering drawings of recent installation of company's Class VL boilers, designed for adaptation to limited space conditions in plants having diverse steam requirements. Text covers main design features of these bent tube boilers. Henry Vogt Machine Co.

231 **Steam Generators**—Engineering data on manufacturer's coal, oil, gas or combination fired package units for generating steam up to 35,000 lb per hour is presented in Bulletin PG-49-13, 12 pp. Includes dimensional data and drawings, a discussion of design features and drawings illustrating firing arrangements. Foster Wheeler Corp.

HEATERS, HEATING

232 **Tubular Heat Exchangers**—Bulletin 916, 32 pp., describes present designs of the company's tubular heaters, coolers, condensers and heat exchangers and their distinctive features. The various types of shells, tube bundles, stationary heads and floating heads are explained. An additional helpful feature are tables of the characteristics of tubing, the thermal resistance of tubes and pipes of many different metals and alloys, and the specific gravity and pounds per gallon corresponding to degrees Baume and API. Also presented are charts of specific heats of midcontinent crude oils and for solving MTD formula with correction factors for other than countercurrent conditions. The Griscom-Russell Co.

233 **Water Heaters**—Illustrated 6-pp Bulletin 70, Section I, on instantaneous type water heaters contains detailed capacity and dimension tables for two-pass, four-pass and six-pass designs, with tube bundles removable for inspection. A typical piping hook-up for installation of these heaters is shown. Also included are instructions for heater selection, engineering data to determine boiler capacities required for heating water, and a chart to determine pipe sizes for any steam flow at most pressures. Davis Engineering Corp.

234 **Combustion Catalysts**—Bulletin 38, 4 pp, explains the action of company's combustion catalysts, including one type developed for use in coal-fired furnaces and another for use in oil-fired furnaces. Tells how they help to remove soot, control smoke and alleviate the slagging problem in boiler furnaces. Also describes a simple hopper-type feeding device available for spraying the catalyst into coal-fired furnaces. National Aluminate Corp.

235 **Heating Unit**—This bulletin presents advantages of company's gas- or oil-fired self-contained industrial heating unit, explaining its operation, simplicity of installation, and describing and illustrating some of its applications. Includes specifications. Also contains engineering data to help analyze industrial heating problems, including procedures to determine heat load, fuel consumption. Thermobloc Div., Prat-Daniel Corp.

235A **Fan Heater Bulletin**—Here's a 2-pp illustrated bulletin (No. 109) on a new high pressure steam fan heater designed for complete utilization of both sensible and latent heat of high pressure steam. One page is devoted to description and photos of the heater. Other page contains a sketch in color showing how the heater works. Niagara Blower Co.

WATER TREATING, CORROSION PREVENTION

236 **Water Conditioning Bulletin**—This is an 8-pp discussion of water and the chemicals developed for conditioning it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition and application. Also discusses special purpose chemicals. Wright Chemical Corp.

237 **Boiler Water Manual**—Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-pp technical bulletin, called Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater system. Also discusses condensate returns, flushing periods, condenser cooling water treatment and chemical tanks. %Proportioneers, Inc.%.

238 **Water Softener Equipment**—How the problems caused by hard water can be offset by the use of water softeners is explained in Bulletin 2386, 12 pp, describing ion exchange equipment. It covers in detail downflow, upflow and gravity zeolite water softeners. Contains a 2-pp cutaway illustration of a fully automatic softener to show how an ion exchanger is built and how it works. Bulletin also contains flow diagrams showing arrangements for installation of water softeners. The Permutit Co.

239 **Anti-Foam Treatment**—This 4-pp bulletin covers a new formula in powder form to be applied along with anti-scale treatment for improving steam quality, controlling scale in boiler feed system and sludge conditioning. It discusses the problem of steam contamination and explains the action of this polyamide anti-foam treatment. Tells how it should be applied and gives dosage requirements. A discussion of its advantages is accompanied by photos showing the effect of polyamide action on a boiling dilute Nacconol solution. Dearborn Chemical Co.

240 **Boiler Corrosion** — A 12-pp article discussing the cause and prevention of corrosion in boiler systems is presented in Betz Technical Paper No. 111 titled "Corrosion: Its Effect in Boiler Systems." The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity and physical factors are evaluated. Numerous illustrations, graphs and tables included. W. H. & L. D. Betz.

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BUILDERS makes a complete line of flow meters and controllers for liquids, steam, air, gas, and dry materials . . . mechanical and differential . . . including the Venturi Meter and Chlorinizers (chlorine gas feeders).

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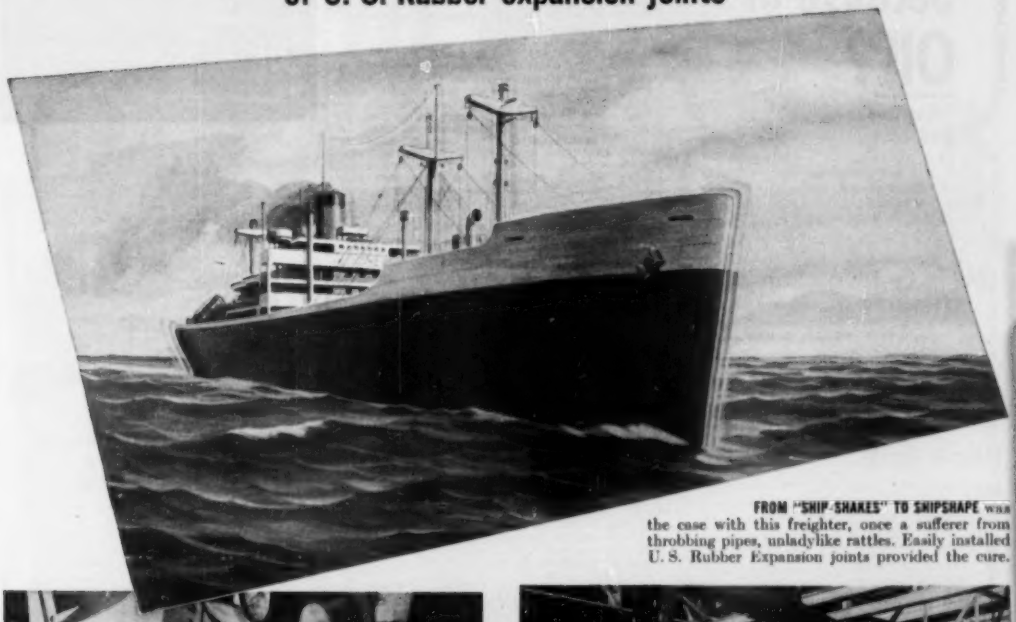
Vibrations and noise in her pipe systems eliminated by installation of U. S. Rubber expansion joints



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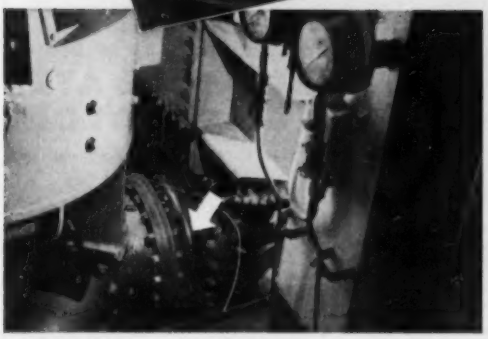
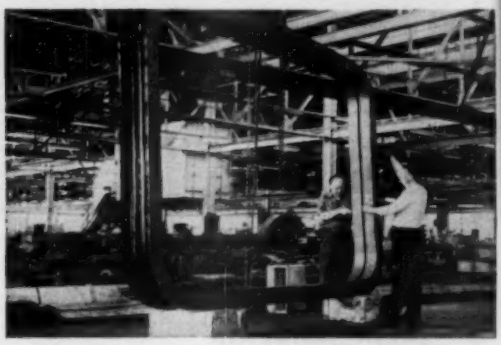


A CASE IN POINT shows compact U. S. Rubber Expansion Joint between circulating water pump and ship's condenser. It allows maximum expansion and contraction in normal operations.



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241 Turbine Blade Deposit Study—Identification and prevention of steam turbine blade deposits and boiler water conditioning to prevent such deposits are discussed in the new 16-pp illustrated Bulletin 28B7030. Describes x-ray diffraction methods employed by the company for identification purposes and the results obtained. Tables list the partial chemical analyses of deposits containing sodium disilicate, occurrence data on compounds found, composition of turbine deposits from turbines operating at various throttle pressures and temperatures, and comparison of compounds found in turbine blade deposits with boiler operating pressures. Allis-Chalmers Mfg. Co.

242 Two-Stage Water Conditioner—Bulletin 4601 describes company's water conditioner which combines the advantages of both hot process and zeolite softening. Explains operation of softener in which the first stage is the hot process using lime or Dolomitic lime and the second stage in which zeolite softener reduces hardness to zero. Discusses advantages of the combination—silica reduction, low alkalinities, lower CO_2 in steam, lower costs and tells applications to high pressure boiler plants. Cochrane Corp.

243 Corrosion Treatment—"Corrosion Protection of Steam and Condensate Return Systems" is a 4-pp folder covering amine treatment for inhibiting of boiler and condensate systems. This treatment is described as affording surface protection of the metal itself as well as raising the pH value of the condensate. Booklet gives specific case histories and typical economies obtained by power plants using this treatment. Includes graphs showing relationship between free CO_2, pH and alkalinity in water, and the solubility of oxygen in water when exposed to air at various pressures. The Bird-Archer Co.

244 Chemical Feed Systems—Single, complete "packaged" units for feeding directly into boiler feed water lines are the subject of 4-pp Bulletin 4611. It discusses in detail sodium sulfite feeding, internal treatment, chemical feeding, manual control, intermittent feeding of internal treating chemicals; automatic feed systems; automatic pH control, and automatic control by conductivity. Illustrations include photos and diagrams of controlled volume pumps. Milton Roy Co.

245 Modern pH and Chlorine Control—This 100-pp booklet is much more than a catalog, although it does give full technical details of all the color comparators and equipment in water testing and control of boiler and industrial process water manufactured by this company. Its most important feature is inclusion of technical information on the meaning of pH control, electrometric and colorimetric methods of determining pH and also determining constituent impurities in water; applications of water control in air conditioning; treatment of boiler feed water and industrial water, and other industrial applications. Color comparators are detailed and illustrated. W. A. Taylor & Co.

246 Water Softeners—Bulletins WC-102 is a 36-pp presentation of recent developments in hot-process water softeners. Explains boiler plant troubles caused by various impurities in water, outlines 12 methods of treating water to eliminate these impurities, describes reasons for the popularity of the hot-process method and its advantages, and explains the chemistry of hot-process water softening. The two basic designs and operation of company's hot process softeners are described, together with six adaptations of each design to various plant conditions, such as per cent make-up, treatment of condensate, deseration. Methods of supplementary hot phosphate treatment are also discussed. Includes diagrams of hot process designs and flow charts, photos of installations. Graver Water Conditioning Co.

247 Boiler Water Treatment—Bulletin 47, 8 pp, is on internal treatment of boiler water. Defines internal treatment and tells its advantages in softening, sludge conditioning, stabilization. Explains operation of company's system, including the chemicals used, feeding and testing equipment. National Aluminate Corp.

248 Plant Wide Water Service—Titled, "Let's Consider Your Whole Water Problem," this 4-pp booklet analyzes water problems from four standpoints—procurement, treatment, usage and disposal—and explains how company is pepared to offer technical service in solving problems related to all four. Hall Laboratories, Inc.

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249 Water Hardness Test—This technical bulletin presents a test procedure for determining hardness of water, by use of a color indicator which is described as both easy and accurate. Instructions for running the test are illustrated in color. Includes prices of company's complete hardness titration set and individual solutions used. W. H. & L. D. Betz.

249A Ion Exchange Systems—"Amberlite Monobed Deonization" is a 12-pp miniature textbook covering the history, behavior, present performance, and potential uses of the Monobed ion exchange systems in water-conditioning, chemical processing and other industries. Reactions of various combinations of exchangers are explained in text and equations. Also discussed are operating costs, equipment costs, quality of product derived, rinse requirements and other properties as they apply to the complete or partial single-step removal of ionized solids from solution. Design and operation of Monobed equipment is described and more than 80 fields of application listed. A table gives nomenclature, chemical behavior and typical uses of six different systems. The Resinous Products Div., Rohm & Haas Co.

PUMPS, COMPRESSORS, ENGINES

250 Centrifugal, Reciprocating Pumps—This is a helpful collection of bulletins covering many types of centrifugal and reciprocating pumps for a wide range of services. Includes data on single-stage and multi-stage pumps, close-coupled pumps, high pressure pumps, pumps especially suited for handling erosive and corrosive liquids and others. Contains photos, dimensions, specifications, ratings and application information. Warren Steam Pump Co., Inc.

251 For Many Pumping Jobs—The Series A313A, latest of company's well-known IMO pumps and especially designed for low cost standardized, quantity production, is described in illustrated Bulletin L313A-B, 8 pp. This is a general service screw-type rotary pump for petroleum products and other light or viscous fluids as required for rotary and steam atomizing oil burners, oil transfer, lubrication, hydraulic systems and similar services. Bulletins contain a cross-section drawing, description of the IMO pumping principle, viscosity tables and motor frame sizes. De Laval Steam Turbine Co.

252 Compressor Selection Chart—Here's a new selection chart, based on normal applications handling air with atmospheric intake pressure. It simplifies selection of proper size compressor for average industrial use, with quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute and shows recommended compressor bore and stroke in inches. Chart covers two letter-size pages. Worthington Pump and Machinery Corp.

253 Air Compressor Lubrication Manual—Valuable information on air compressor maintenance is contained in this 40-page book on the lubrication of air compressors, second edition. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements, operating hints, oil requirements, storage and care of compressor oils, and safety precautions. All discussions are illustrated. Cities Service Oil Co. (In the South, Akansas Fuel Oil Co.)

254 Modern Steam Engines—In presenting steam engines as more than "just drives," Bulletin 306 touches briefly upon some of the advantages of "by-product" power. Bulletin features company's vertical steam engines of both throttling and automatic governor types. Sectional drawings are accompanied by engineering data, an illustrated discussion of construction features and photos of installations. Troy Engine & Machine Co.

255 Pump Packings—Packings for use on reciprocating and centrifugal pumps are illustrated by photo and described in this 4-pp folder. It covers packings for practically all services and includes a table of recommendations to facilitate selecting the right packing for any particular application. Johns-Manville.

TURBINES

256 Turbine Catalog Collection—This is a valuable collection of bulletins in loose-leaf form. They cover a complete description of manufacturer's solid wheel turbines and feature cross section draw-

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ings of typical units for both moderate and high steam pressure conditions. Also provides a description of an axial flow impulse, both single and multi-stage, and complete data on speed increasing and speed reduction gears. The Terry Steam Turbine Co.

257 **Velocity Stage Turbines**—Catalog 82-19R, 8 pp, features turbines for mechanical drives designed to operate under all inlet steam conditions up to 600 psig and 750 F. Gives complete specifications, dimensions and includes chart showing how to estimate turbine sizes. Illustrations include cutaway view, photos of parts. Speed governor and regulating valve, and emergency governor and trip valve are described. De Laval Steam Turbine Co.

FUELS, LUBRICANTS

258 **Steam Power Plant Auxiliaries**—In Vol. 36, No. 4, of Lubrication, a technical publication on selection and use of lubricants, is an article on recommended lubrication practices for steam power plant auxiliaries. Illustrated with photos and sketches, it discusses automatic coal firing machinery, stoker design, pulverizers, tube cleaners, compressors, motors, fans and blowers, external reciprocating elements of pumps and compressors. The Texas Co.

259 **Diesels, Their Fuels and Lubricants**—This 46-pp book offers a well organized and attractive presentation of practical information on diesel engines, covering their history and economics as well as discussing their design characteristics and operating principles. Classification of diesels according to speed is explained. Other chapters cover injection systems, combustion chambers, lubricating systems, and diesel oil purification and filtration. The balance of the book is devoted to a discussion of fuel and lubricating oil required by diesels and description of company's products. Book is filled with photos, sectional illustrations and schematic drawings; includes table showing relation of engine performance characteristics to fuel properties. Sinclair Refining Co.

260 **Fuel Oil Treatment**—By text and sketches, this folder points out undesirable conditions in the storing, pumping, heating and burning of industrial fuel oil and the correction of these conditions by company's fuel oil treatment. Defines sludge and includes instructions for application of the fuel oil treatment. E. F. Drew & Co., Inc.

261 **The Answers on Turbine Oil**—This 2-pp booklet answers several questions power engineers ask about turbine oils, including: What causes deposits of sludge? What causes acidity increase? What causes corrosion in turbines? Explanations are brief but thorough. Booklet is illustrated with photos of turbine installations in which manufacturer's products have been used successfully. Standard Oil Co. (Indiana).

262 **Coal Scale Manual**—Recently-published Bulletin 0150 describes automatic coal scale construction and operation, illustrating special design features which provide for high accuracy and long service. Included in this book are installation photos, working drawings for typical installations, as well as dimensional data. Richardson Scale Co.

263 **Spreader Stokers**—Catalog 80, 44 pp, describes a spreader stoker with forward moving grate that slowly and continuously discharges ash at the front. Explains the efficiency and economy of this stoker, illustrating grate's design and operation. Includes discussion of typical power plant installations of these stokers, covering more than 30 industrial, institutional, municipal and public utility installations through the country. These are illustrated by photos and blueprint drawings. Detroit Stoker Co.

264 **Coal Handling Equipment**—Modern equipment for the storage and handling of coal and ash is presented in 24-pp Bulletin 300. Illustrated with sketches and photos of actual installations, it covers concrete and tile silos, cylindrical steel tanks, and suspended steel bunkers with gravity discharge bucket elevators and pivoted bucket carriers. Gifford-Wood Co.

265 **Spreader Stoker**—Bulletin SB 31, 4 pp, explains and illustrates, by photos, the design and construction features of company's spreader stokers, stressing their advantages. Also contains photos of installations. Erie City Iron Works.

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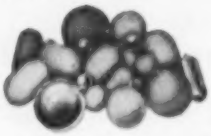

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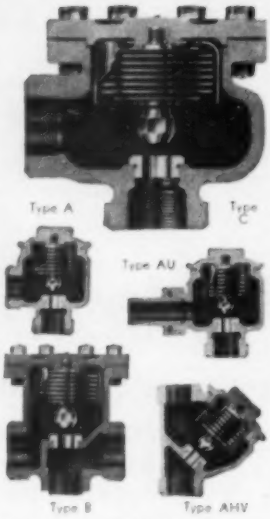

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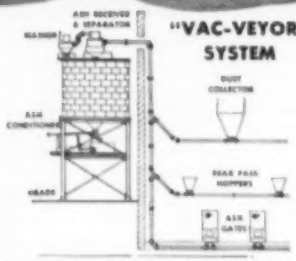

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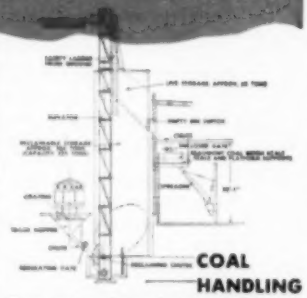

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266 **Small Crushers**—"For Better Testing and Small Scale Reduction" is the title of this 6-pp bulletin describing in detail the many practical applications of company's small crushers, grinders, and shredders for reduction of coal, by-products, chemicals, clays and many other products. Typical installations are clearly diagrammed and explained. Special attention is devoted to construction features and functional advantages of the different mills as applied to various reduction jobs. American Pulverizer Co.

267 **Spreader Stoker Selection** — Fourteen-pp Form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered in the selection. It pictures and describes in detail the principle operating parts of manufacturer's stokers, emphasizing their advantages. Includes engineering drawings and photos of typical installations. American Engineering Co.

267A **Spreader Stoker Data**—This is a file of three illustrated bulletins on company's spreader stokers. The first discusses seven reasons for selecting these stokers and describes their design, construction and operating features. The second is devoted to a discussion of the dumping grate mechanism and the third illustrates 15 typical installations. Riley Stoker Corp.

DUST COLLECTING

268 **Fly Ash Elimination** — Power engineers will find this 36-pp booklet outstanding among material on this subject. It presents manufacturer's "Multiclone" equipment (described as small-tube type of cyclonic dust collectors using centrifugal force for separating dust from gas stream) as a highly successful and economical means of separating fly ash—not as a panacea for all cinder and fly ash problems. Parts and assemblies are illustrated by photos and drawings and explained in terms of construction, operation and capacities. Particle size and its significance in fly ash elimination, is discussed and so is dust collecting efficiency as affected by operating conditions. Western Precipitation Corp.

269 **Dust Collectors** — Dust collecting equipment for power plants, foundries, cement plants and similar industries is the subject of Bulletin No. 1428, 26 pp. Contains many photographs of installations, also photos showing equipment being tested in company laboratories. Discusses services offered by manufacturer in analyzing individual installation requirements. American Blower Corp.

270 **Dust Collecting Efficiency**—How the higher and narrower inlet utilized in company's tubular dust collector contributes to more efficient dust collecting is explained in this illustrated bulletin. Cutaway drawings showing tube design and micron efficiency curves accompany the text. Prat-Daniel Corp.

METALS

270A **Engineering Data on Inconel**—In addition to providing extensive information on Inconel, 24-pp Bulletin T-7 also presents details on the composition, mechanical properties and physical constants of Inconel X, one of the newer age-hardened Inco nickel alloys. The International Nickel Co., Inc.

271 **Steels for Hot Spots** — This is an 88-pp manual filled with information on steels for elevated temperature service. Includes a discussion of the general principles of high temperature behaviour of ferrous materials and the factors influencing their behavior; a data section replete with tabular and graphical material covering mechanical property values of 21 steels; and illustrated description of major high temperature testing facilities in the United States, and a comprehensive bibliography of company's technical publications on the properties and use of steel at high temperatures. United States Steel.

272 **Corrosion Resistance of Nickel Alloys** —Technical Bulletin T-3 contains 44-pp of illustrated information on the resistance of high nickel alloys to corrosion by sulfuric acid. Although technical in nature, it is written so as to be readily understood by non-technical staffs. Performance of 30 nickel-bearing materials in a wide range of service is discussed, and there are 86 tables and 33 graphs and photos. Problems involving a wide range

(Continued on page 132)

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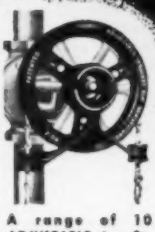

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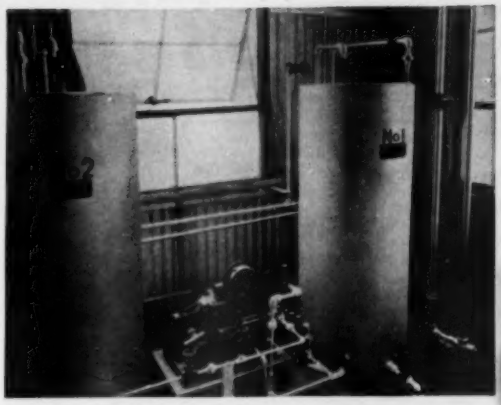

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The need for correct boiler water treatment is well recognized. Authorities agree that two distinct methods, sulphite feeding and internal treatment, are usually necessary.

Removal of dissolved oxygen, insurance against corrosion, and prevention of pitting requires the continuous addition of sodium sulphite solution to the feed water. Internal treating with various chemicals is necessary to retard scale formation, control alkalinity and prevent embrittlement.

Milton Roy Systems for boiler water treatment are complete "Packaged" units ready for immediate installation. Included are all necessary solution tanks, covers, gages, low-level cutouts and alarms, motor starters, and pumps as required. Automatic electronic controls can be supplied to operate pumps at speeds proportional to feed water flow as measured by flow meters. Systems are available to handle all treating chemicals and to meet any capacity and pressure requirement.

For complete information ask for Bulletin No. 4811.

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Egbert's eyes would shine if he could see how quickly and thoroughly Wilson Tube Cleaners remove scale and other deposits from boiler tubes. There is an easy-to-handle Wilson Tube Cleaner for every kind of scale — hard or soft, thick or thin, variable in depth. A large variety of cutter heads and accessories make it simple to clean straight or curved tubes. Wilson Tube Cleaners — driven by air, steam, water or electricity — do a "custom" job, save down-time, are more economical.

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Use them to re-roll old tubes or install new ones. Precision manufactured Wilson-Dudgeon Tube Expanders insure solid seating, easy rolling. All sizes, in flaring and non-flaring types, available.

WRITE FOR BULLETIN 47-A
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THOMAS C. WILSON, INC., 21-11 44th AVENUE, LONG ISLAND CITY 1, N. Y.

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WILSON

WILSON TUBE CLEANERS
WILSON-DUDGEON TUBE EXPANDERS

(Continued from page 128)

of operations are covered. The International Nickel Co., Inc.

MECHANICAL POWER TRANSMISSION

273 Transmission Belting — Catalog M-9032, 28 pp, gives detailed design, engineering and performance data on manufacturer's line of transmission belting. Tables on belt speeds, arc of contact, friction, horsepower correction, and service factors are included in the manual, together with hints on proper selection of a belt and procedure for analyzing belt drives. Illustrations include many photos of belt installations and drawings of transmission drives. United States Rubber Co.

274 Traffic Cops for Speed Drives—Book 2349, 8 pp, introduces a new line of automatic speed controls for use with company's PIV variable speed drive, which are designed to automatically control output speed range. Describes and illustrates the four available types—electronic, pneumatic, hydraulic and mechanical. Includes diagrams of job engineered applications covering some of the many industrial uses for these controls. Link-Belt Co.

OTHER EQUIPMENT

275 Condensers — Bulletin 441-C, 28-pp, covers in detail every phase of manufacturer's line of condensers—their simplicity of design, accessibility, construction features. Illustrated with photos and drawings showing complete assemblies, parts, principles of operation. Bulletin also discusses emergency replacements, service and maintenance facilities available, and auxiliary equipment. Includes condenser tube data, pressure-conversion tables. Condenser Service & Engineering Co.

276 Concrete Floors Q & A — The detailed information contained in this booklet brings up to date, the service experiences and late developments in this field. The information covers methods and materials used in placing corrosion resistant concrete in a wide variety of industrial applications. Typical uses of corrosion resistant concrete are listed for many industries and also given, are the answers to questions often asked about it. Lumnite Division, Universal Atlas Cement Co.

277 Corrosion Analysis—Excellent working data on galvanic corrosion is contained in this 8-pp technical study of corrosion by concentration cells, reprinted from Inco Corrosion Reporter, Vol. 3, No. 1. Discusses concentration cells, the metal-ion cell type, oxygen cell type, reversible concentration cells, their practical aspects and some rules for minimizing or preventing concentration cell corrosion. Illustrated with sketches showing conditions which accelerate corrosion. The International Nickel Co., Inc.

278 Wired Television—Illustrated Bulletin 1035, 16 pp, introduces company's Utilscope, a camera and monitor type of equipment designed to enable an observer to see where he can't look. Some of the many applications for this wired television which are described and illustrated include viewing instrument readings at remote points, checking boiler water levels, watching coal flow in chutes, watching hazardous laboratory tests, checking furnace ignition. Diamond Power Specialty Corp.

279 Cleaning Industrial Equipment—This is a general information bulletin on manufacturer's service for cleaning steam generating, heat exchange and other industrial equipment. Also included is information on pipe line cleaning and water well acidizing. Illustrations of these services are included, and bulletin treats in detail the methods used to remove incrustations from internal surfaces economically with minimum of downtime. Dowell Inc.

280 Fluid Reduction Mills — Bulletin 430-1, 8-pp, introducing company's fluid energy reduction mill, discusses the advantages of finer particle size in many processing operations. Illustrates the mill and explains its grinding operation. C. H. Wheeler Mfg. Co.

281 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads, discussing special features. Also includes data on motors and hose for use with cleaners. Roto Div., Elliott Co.

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Good Opportunities for
POWER ENGINEERS

Must have 8 to 12 years experience in operating, testing and maintaining power plant equipment, supervising power plant operations, making cost and evaluation studies, heat balance work, power cost accounting and the selection and installation of power equipment. Must be graduate.

Give experience, education, age, references, personal history, salary received and salary expected. Please be complete and specific.

All inquiries will be considered promptly and kept confidential.

E. I. du Pont de Nemours & Co. (Inc.)

Engineering Department Personnel
Wilmington 98, Delaware

New *VERSENE** test kit determines total water hardness in less than *TWO MINUTES*

Now, with this new Versene* water hardness testing kit you can determine the hardness of your own boiler, process or tap water as easy as ABC—in less than 2 minutes. Anyone who can tell red from blue can make this scientific versenate test and be accurate within one grain of hardness per gallon.

Handy, sturdy, pocket-size plastic kit contains 3 vials of chemicals and one combination measuring and mixing vial. More than 50 separate tests can be made, depending on water hardness. Complete instructions. Refills available. Order The New Versene* Water Hardness Testing Kit today. $5.00 Postpaid. Send Checks or M.O. No C.O.D.'s. Money Back Guarantee.

We also manufacture and supply Inhibited Indicator and Di Sodium Versenate (the di sodium salt of ethylene diamine tetra-acetic acid). These are the reagents used in the Versenate (Schwartzenbach) Method for the determination of Water Hardness.

Di Sodium Versenate
50 g. $2.00 — 100 g. $3.00 — 500 g. $10.00
Inhibited Indicator
100 cc $1.00 — 250 cc $2.00 — 500 cc $3.00 — 1000 cc $5.00

BERSWORTH CHEMICAL COMPANY
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For Every Application

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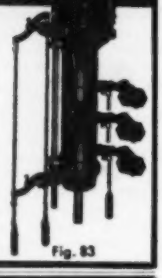

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LIVINGSTON N. J.

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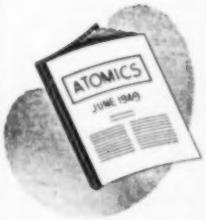
ATOMICS



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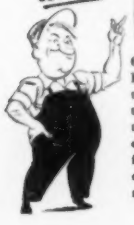
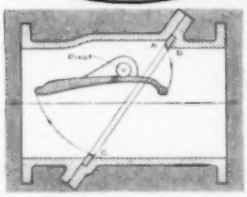
ATOMICS - 110 S. Dearborn St. - Chicago 3, Ill.

STOP Destructive Pipe-Line Stresses

with CHAPMAN TILTING-DISC CHECK VALVES





Cross-section of the Chapman Tilting Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

When you reduce slamming you reduce the hazard of rupturing pipe lines, opening up joints . . . . a host of maintenance problems.

That is why we suggest you investigate Chapman Tilting-Disc Check Valves. The balanced disc in this unusual valve lifts away easily in opening . . . rides smoothly on the flow . . . closes quickly but quietly. There's no slamming . . . minimum wear on valve parts and minimum stresses on pipe lines.

Special designs with dashpots are also available for use under unusual operating conditions, where no self-acting Check Valves can function satisfactorily.

Made in both iron and steel . . . pressures up to 3000 pounds.

You'll find it will pay you to write today for more information on this valve developed by Chapman. Request Bulletin #30.

The Chapman Valve Mfg. Co.

INDIAN ORCHARD, MASSACHUSETTS

PROTECT YOUR TURBINES THIS BETTER WAY

Lubricate with Texaco Regal Oils (R&O) and assure freedom from rust, sludge and foam

AIR and water are bound to get into turbine oil. When ordinary oils are used, oxidation speeds up, rust and sludge are likely to form—particularly if the oil has a tendency to foam. To avoid these trouble-makers, use *Texaco Regal Oils (R&O)*.

In making the world-famous *Texaco Regal Oils (R&O)*, the choicest base stocks are first refined into top-quality straight mineral turbine oils; then further improved by additives to inhibit rust and oxidation, and specially processed to prevent foaming. This extra care pays off in extra protection for your turbines.

Texaco Regal Oils (R&O) keep lubricating systems clean, free of rust and sludge... assuring normal bearing temperatures and instantly responsive governor action. *Texaco Regal Oils (R&O)* meet the exacting requirements of all leading turbine builders, and have an extra long service life.

Let a Texaco Lubrication Engineer show you specifically how your turbines and auxiliaries can benefit from the use of Texaco products. Just call the nearest of the more than 2,000 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 E. 42nd St., New York 17, N.Y.

TEXACO

TEXACO Regal Oils (R&O)

FOR ALL TURBINES

TUNE IN... TEXACO STAR THEATER starring MILTON BERLE on television every Tuesday night. See newspaper for time and station.